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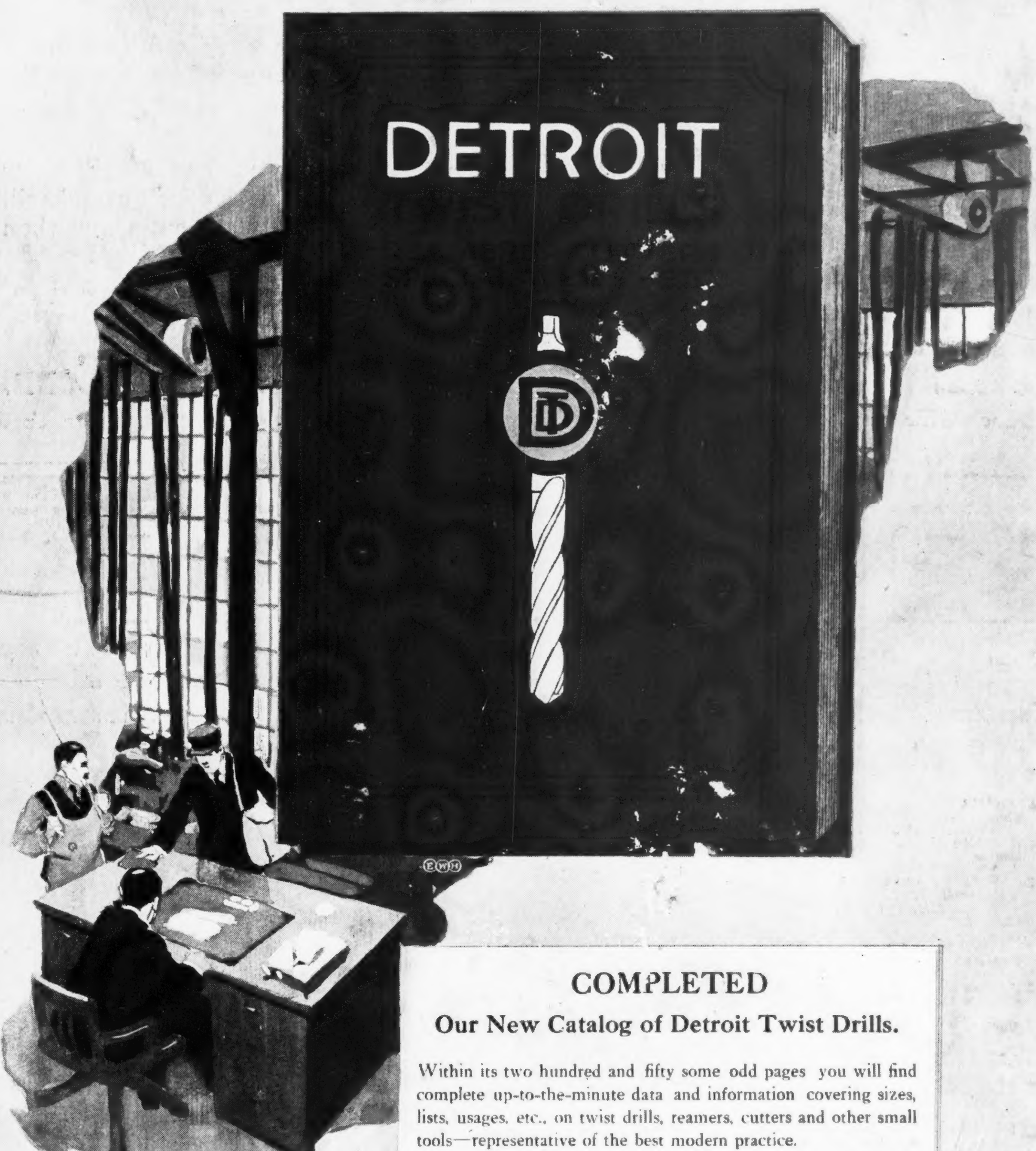

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The Caterpillar Tractor

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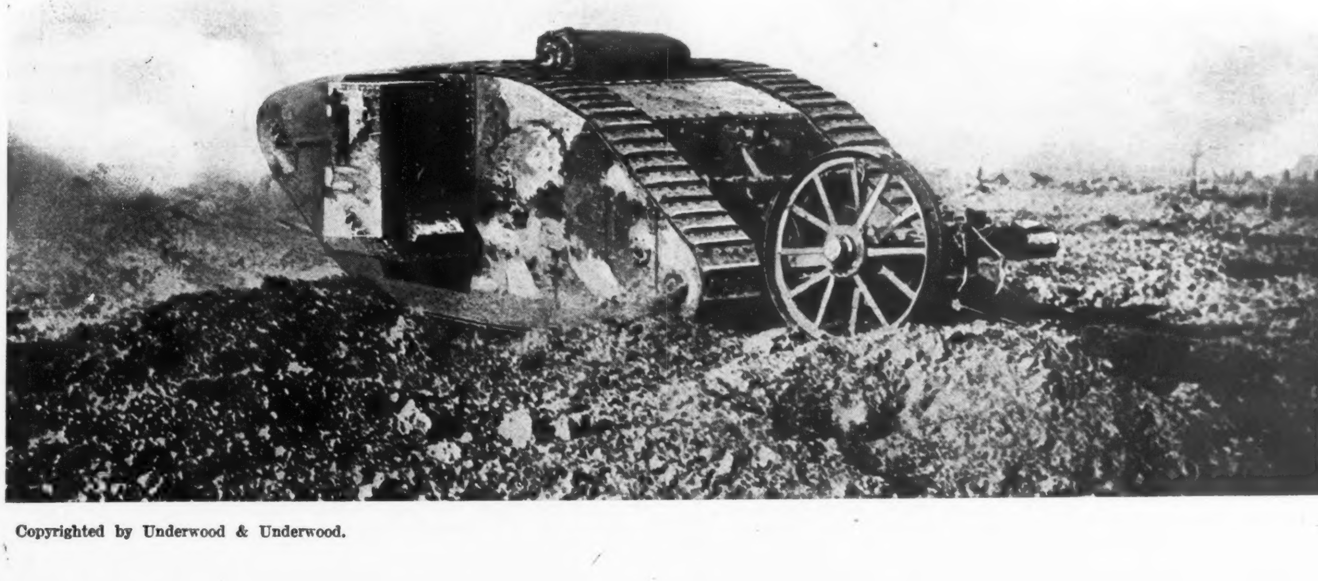
The importance of road transportation in times of war and peace warrants the presentation of this article on the design and construction of the Holt Mfg. Co.'s caterpillar tractor, which is the foundation of the British and French "tanks," and in many respects the most remarkable machine ever developed for any purpose.

WAR stimulates the invention of destructive devices and promotes the adaptation of machines to offensive purposes for which they were not originally planned. One of the strange developments of the European struggle is the so-called "tanks," those lumbering land battleships, invulnerable to machine-gun fire, that travel over ground plowed by shells, and cross ditches, crawl up precipitous banks, push down walls, and accomplish that which would be impossible for any of the four-wheel type motor trucks. The tanks are adaptations of an American invention, being reconstructed caterpillar[1] tractors built in the United States and invented by Benjamin Holt, president of the Holt Mfg. Co., of Stockton, Cal., and Peoria, Ill.

Benjamin Holt was born in New Hampshire and had New England thrift and native Yankee inventive ability. He went to California in the early eighties, and with his brothers established a factory at Stockton for building wagons and farm implements. The vast agricultural areas, the forests and the great mines of the Pacific coast all demanded new methods of farming, lumbering and mining. Twenty-five years ago Mr. Holt invented the Holt combined harvester and thresher, which cuts and threshes the grain at one operation. This machine quickly came into extensive use in the Pacific coast states. Mr. Holt then began the manufacture of steam traction engines for pulling gangs of plows and other tillage implements, but these engines were only partially successful, as the soft lands of the San Joaquin valley could not support the weight, although driving wheels were built as large as eight feet wide and twelve feet diameter. These were too heavy and cumbersome and did much damage to the surface traversed. Then realizing that the reason for using such enormous driving wheels was simply to obtain the projected area on the ground required to support the weight, Mr. Holt, in 1904, discarded the large-diameter, wide-tire wheels and designed a virtually flat wheel in the form of an endless sectional track which the tractor first lays down, rolls over and then finally picks up one section at a time, thus giving a solid steel road-bed to travel on. The belts were provided with guide wheels similar to an animal tread power, and, in fact, the driving elements or track assemblies are identical in principle with tread powers; they are laid on the ground

[1] The term "Caterpillar" used throughout this article is copyrighted, and has reference only to the tractor made by the Holt Mfg. Co.



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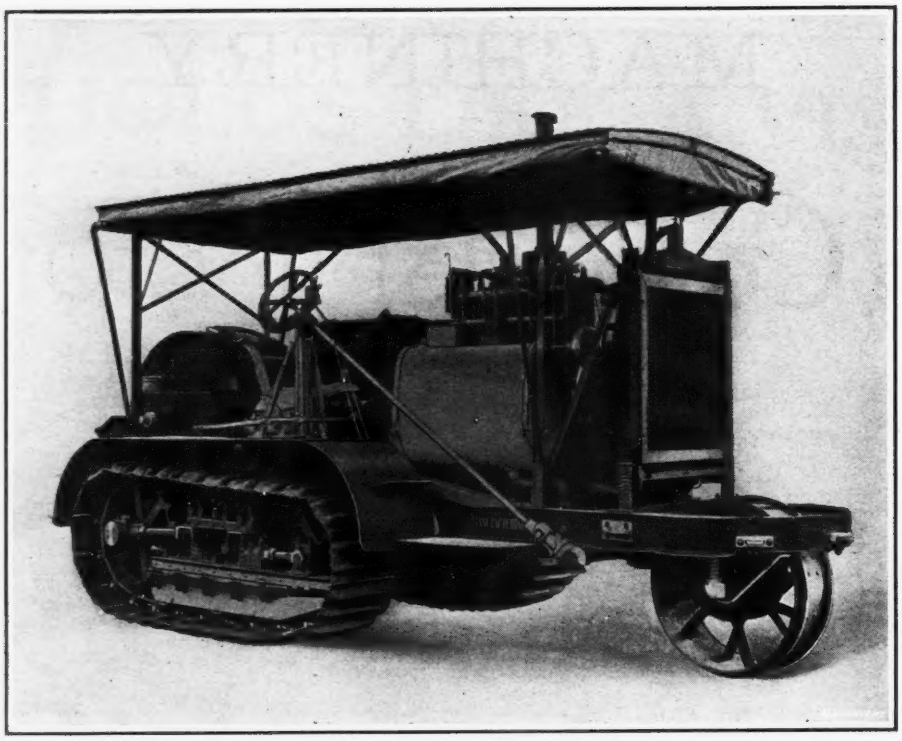

Fig. 1. Seventy-five-horsepower Internal-combustion Motor Caterpillar Tractor

and pushed by engine power instead of being pushed by animal power. The engine drives through sprocket wheels, which engage the links of the belt or chain. This form of driving element can be proportioned to give almost any required area to support the load, and it was found to have certain other valuable characteristics not possessed by the traction engine. It not only had great tractive power, but could be maneuvered much more easily. It is possible to turn a caterpillar within its own length and to traverse broken ground that would stop any wheel vehicle. The reason for the latter is that the belts bridge narrow ditches and support the engine without dropping in and having to climb out. If the ditch is broad, the great tractive power enables the machine to cross even if the sides are inclined at as steep an angle as 45 degrees.

The Holt Mfg. Co.'s caterpillar tractors are built in four sizes, *viz.*, 18, 45, 75 and 120 horsepower. The 18- and 45-horsepower sizes have no pilot or leading wheel. The larger sizes with greater power and a longer wheel-base are employed for heavy hauling, as well as for agricultural work, having power sufficient for pulling large gangs of plows or several loaded trailers, doing construction work and other labor requiring great tractive power. The 75-horsepower tractor weighs 24,000 pounds and develops a draw-bar pull of 9000 pounds; the 125-horsepower tractor develops 12,000 pounds draw-bar pull.

The tractors are equipped with internal combustion four-stroke cycle engines with four and six cylinders. The six-cylinder engines are used on the 75- and 120-horsepower tractors, while the 18- and 45-horsepower sizes have four-cylinder engines. The 45- and 75-horsepower motors are built in the Stockton plant, and the Peoria plant is devoted principally to the construction of the frames, track assemblies, clutches, transmission gears, and all the other principal parts. A few six-cylinder engines with certain special features for military tractors are built in the Peoria plant. The general design of the engine does not differ radically, however, from that of the engines for motor trucks except in general ruggedness and strength, being comparatively slow speed and heavy per unit horsepower. The 75-horsepower tractor is driven at two speeds, either 2⅛ and 3, or 1½ and 2⅛ miles per hour. The slow speeds, of course, give the greatest tractive power and are used in heavy pulling. When climbing a bank or getting out of a mud-hole, the operator uses the multiple-disk master clutch to increase the tractive power momentarily. He lets the engine speed up and then jams in the clutch, thus utilizing the inertia of the flywheel and obtaining a tremendously increased tractive power momentarily. It is because of the peculiar features of the driving gear and the low unit pressure of the tractor on the earth that the Holt caterpillar can cross gullies, plow through mud, and pull a load where other tractors would be practically helpless.

The control of the Holt tractor is different from that of the ordinary motor truck. On the 45-horsepower tractor the operator's seat is at the rear, where he has at his hand and feet three clutches to operate, two for steering and one—the master clutch—for controlling the transmission of power from the engine to the driving gear. The master clutch must be pressed into engagement by the operator when he wishes to drive, instead of employing the pressure of a coiled spring, as in the transmission of the ordinary motor car. The two steering cone clutches are located in the jack-shaft. To turn the tractor to the right, the operator releases the right-hand clutch partially or entirely, depending on the shortness of the turn required, and drives with the left-hand clutch, causing the machine to curve to the right. If a very short turn is to be made, the right-hand clutch is fully disengaged and the brake applied to the clutch drum, thereby locking the driving gear on the right-hand side and causing the machine to pivot on the center of the right-hand track assembly. Thus it is possible to turn the tractor easily within its own length.

Caterpillar tractors are manufactured, but all the parts are not made strictly interchangeable, although they are practically so. For instance, the bearings for the transmission shafts are babbitted with babbitting jigs and are afterward reamed, scraped and fitted to their respective shafts, thus securing close fits,

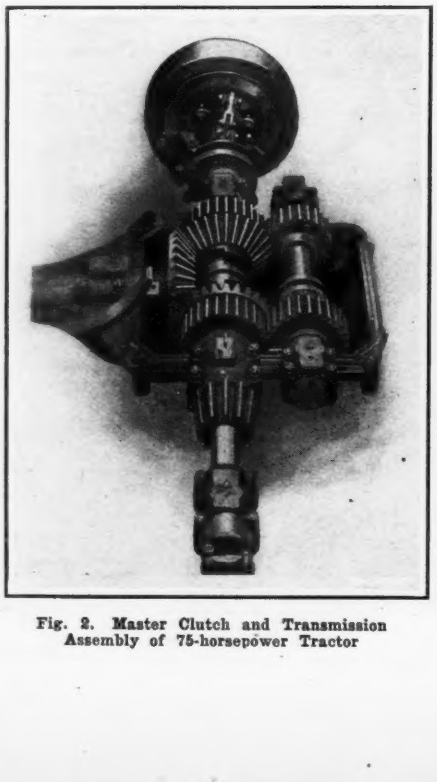

Fig. 2. Master Clutch and Transmission Assembly of 75-horsepower Tractor

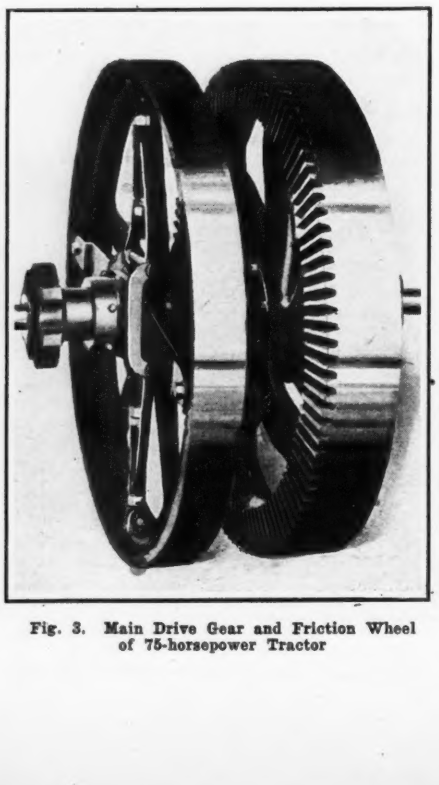

Fig. 3. Main Drive Gear and Friction Wheel of 75-horsepower Tractor

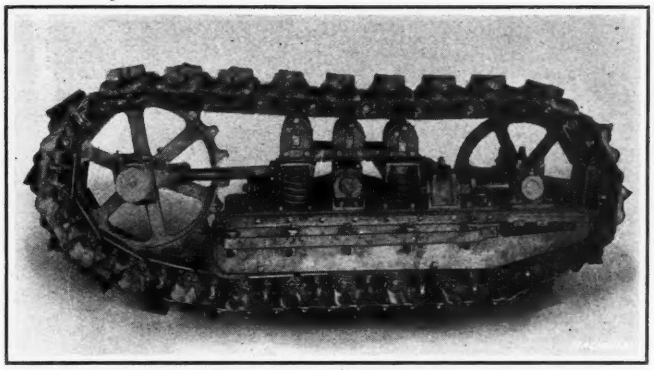

Fig. 4. Track Assembly of 75-horsepower Holt Caterpillar Tractor

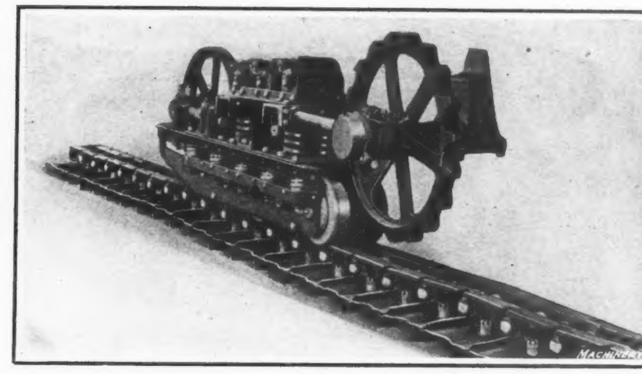

Fig. 5. Track Assembly with Track opened out, 75-horsepower Tractor

smooth action and durability. When replacements are necessary, some refitting may have to be done. The frame is bent to shape over forms and the bearing castings are set, the holes are drilled and then reamed in position. The general practice is the same as that followed by locomotive builders. The effort is to secure a strong, well-knit construction that will withstand indefinitely the shock and wear of use.

Cut gears are used throughout the transmission. The bevel gears are planed on Gleason bevel gear templet planers. Great

Fig. 6. Machine Shop of Holt Mfg. Co., Peoria, Ill.

care is exercised to obtain perfect alignment of engine crankshaft bearings, the boring being done on Lucas horizontal machines.

The working parts of the caterpillar that excite the liveliest interest in the mechanic are the track assemblies. In these we have a mechanism exposed to dust, sand, mud and water, while working under heavy stress. To have designed and constructed a flexible steel track that sustains a load of several thousand pounds and that propels the machine under the most severe deteriorating influences is an accomplishment worthy of the highest commendation. The structure is made to exclude dirt to a considerable extent, but it works without trouble or rapid wear when submerged in mud or sand.

The steel track of the caterpillar is composed of links, connected by casehardened pins and bushings, and plow steel plates pressed into shape while hot. Each link is a double rail over which the track rollers revolve. A plow steel plate

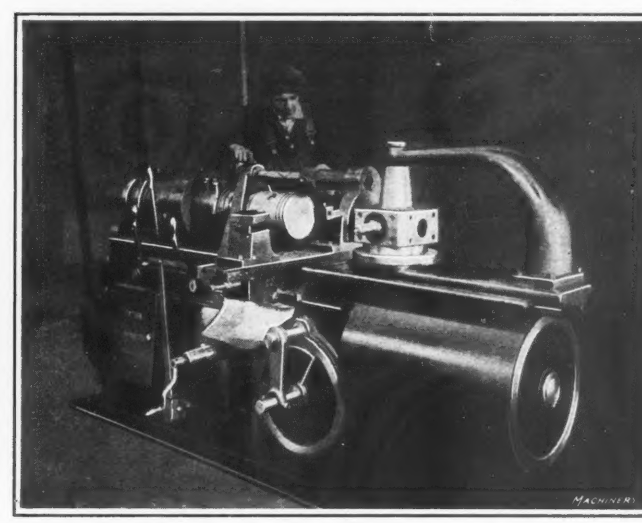

Fig. 7. Potter & Johnston Automatic Lathe turning Pistons

of high tensile strength is attached to each link. The plates have curved ends and overlap, so there is no opening between them in any position. They are made sufficiently heavy to withstand severe use and, owing to the design and materials used in construction, are extremely durable. There is little or no friction between the plates and the ground, the track being merely laid down and picked up again, one section at a time.

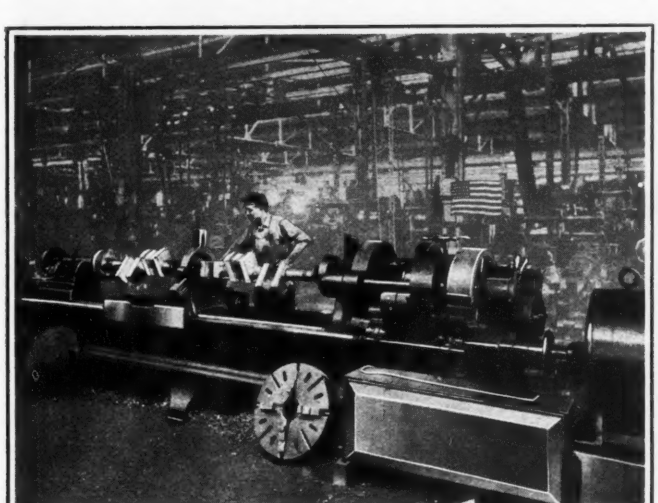

Fig. 8. Turning Six-throw Crankshafts for 120-horsepower Engine

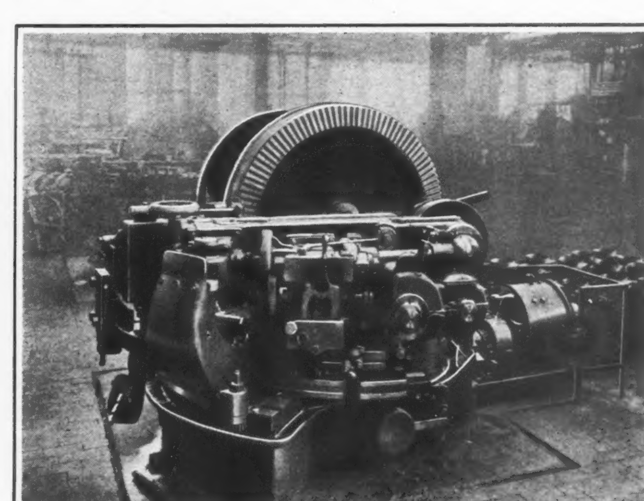

Fig. 9. Gleason Templet Gear Planer planing Bevel Main Drive Gears

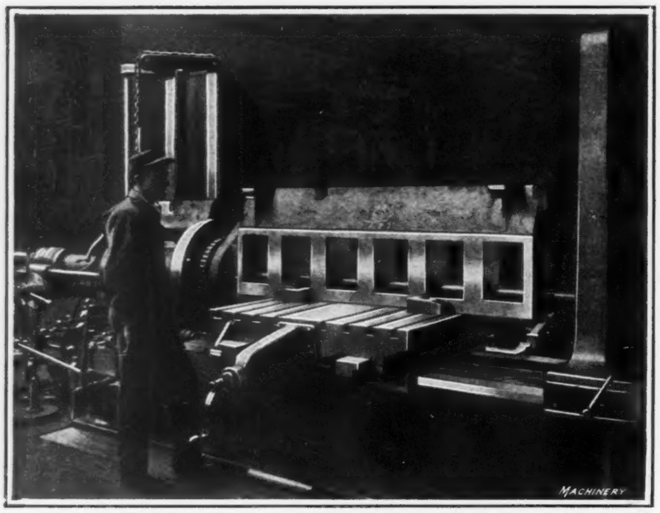

Fig. 10. Lucas Horizontal Milling and Boring Machine boring Bearing for Six-cylinder, 120-horsepower Crank-cases

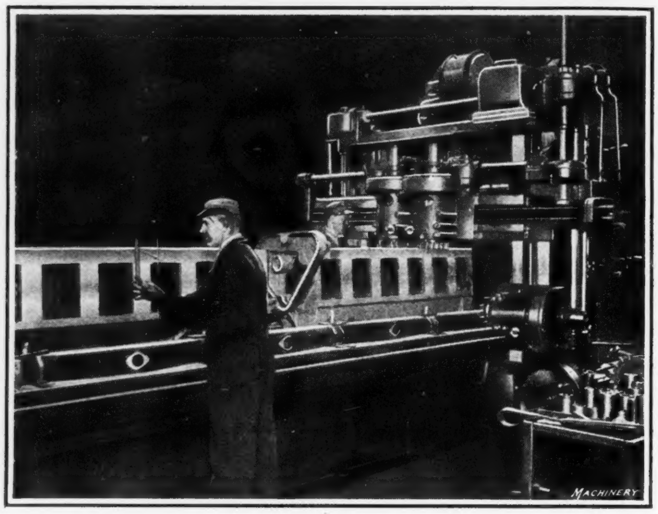

Fig. 11. Ingersoll Milling Machine working on Crank-case of Six-cylinder, 120-horsepower Engine and Radiator Headers simultaneously

The extraordinary capacity of the caterpillar to travel over soft ground is due in large part to the low unit pressure imposed on the supporting track. There are usually eight track links or shoes on each track of a 45-horsepower tractor in contact with the ground, so that with the standard 13-inch width tracks the total bearing surface is 2080 square inches and the ground pressure is only 6¼ pounds per square inch. For very soft ground, special 30-inch width tracks are provided, giving a total bearing surface of 4800 square inches and reducing the ground pressure to 3 pounds per square inch, or 432 pounds per square foot. This pressure is much less than the foot pressure of either man or horse; hence it is obvious that the heavy tractor can work over soft soils, and will pack the ground less than horses.

The load is transferred on each side of the 45-horsepower caterpillar to five truck wheels or rollers, spring-supported beneath the main frame. The driving sprocket is at the rear and small rollers are provided at the top for supporting the chain as it travels to the blank sprocket or idler at the forward end. The truck rollers have chilled faces and revolve on heat-treated shafts fitted with long phosphor-bronze bearings provided with grease cups. The hubs are counterbored to receive washers that are ground to size. The washers act as a thrust bearing and exclude dust, sand and dirt.

Fig. 12. Main Erecting Shop of the Holt Mfg. Co., Peoria, Ill.

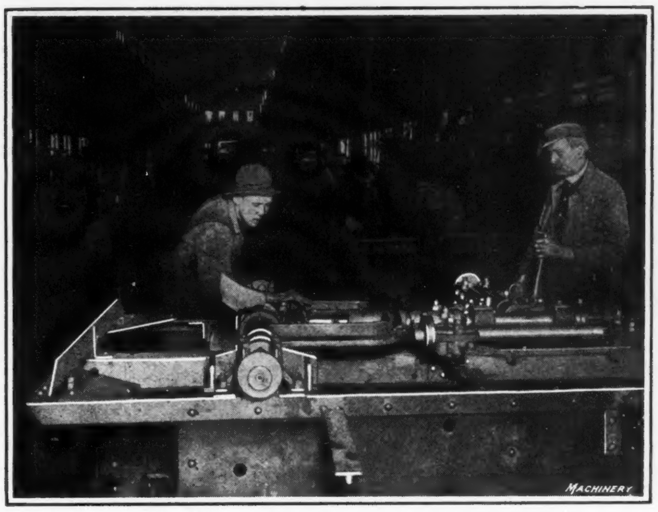

Fig. 13. Babbitting Jig used for Bearings of 75-horsepower Tractors

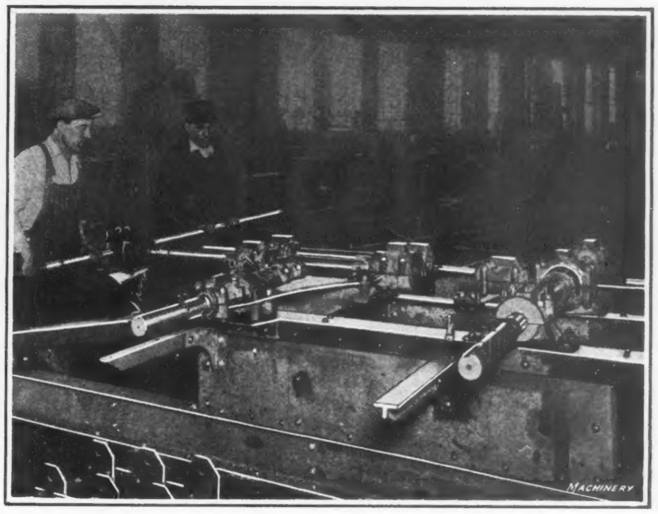

Fig. 14. Power Reamer for reaming Bearings on 75-horsepower Tractor

The gasoline tanks are made of galvanized sheet steel, rolled and spot-welded closely at the seams. The heads are formed with shallow flanges and set in place with the flanges outward in the spot-welded shell. The heads are closely spot-welded to the shell and then all seams are soldered. The spot-welding process of uniting the seams is rapid and effective; the spot-welds give the seam the necessary strength to hold and the solder seals the joints.

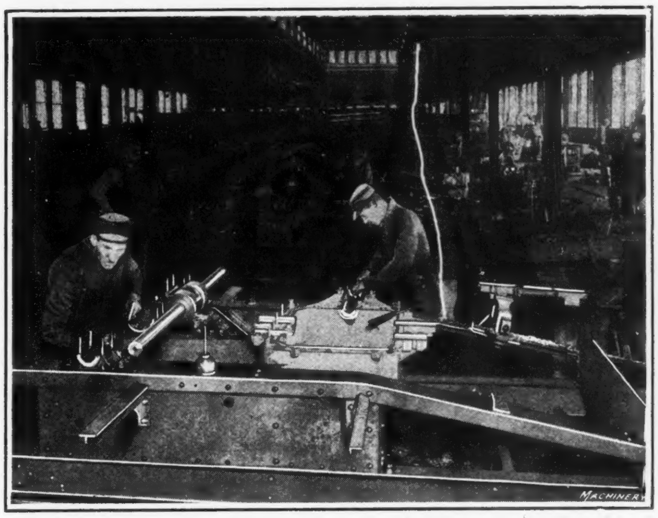

Fig. 15. Scraping Bearings for 75- and 120-horsepower Tractors

All tractors are subjected to a shop test of several hours' duration, running under brake load, to tune them up and get the bearings broken in. After the brake test, each tractor is taken out and driven about under heavy load until the operator is satisfied that it is fit for average road conditions.

Motor trucks and tractors are being widely used in the European war for hauling in place of horses. The movement of great guns and supply trains with the speed and rapidity accomplished would have been out of the question if the armies had to depend on horses. The extent to which mechanical traction is used is indicated in a manner by the fact that the Holt Mfg. Co. has sold over three thousand caterpillar tractors to the European countries, chiefly Great Britain and France. The advantages of motor-driven tractors are greater concentrated power than is possible with horses, freedom from disease, smaller number of men required to drive and care for them, capacity to travel continuously over rough roads, and possibility of being restored to use when damaged by shells.

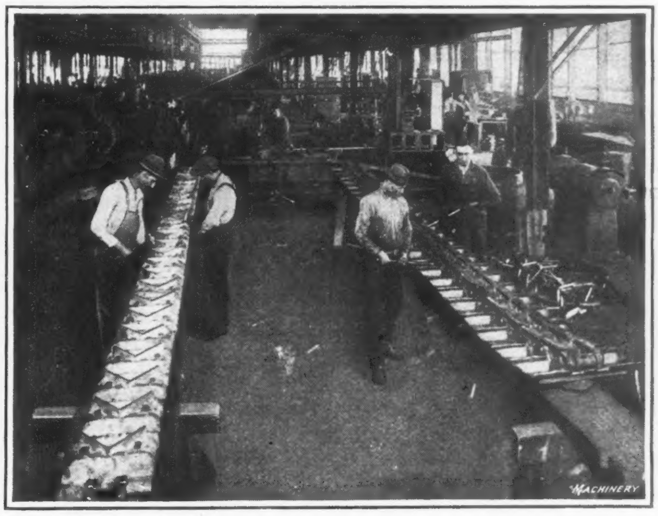

Fig. 16. Assembling Tracks for 75-horsepower Tractors

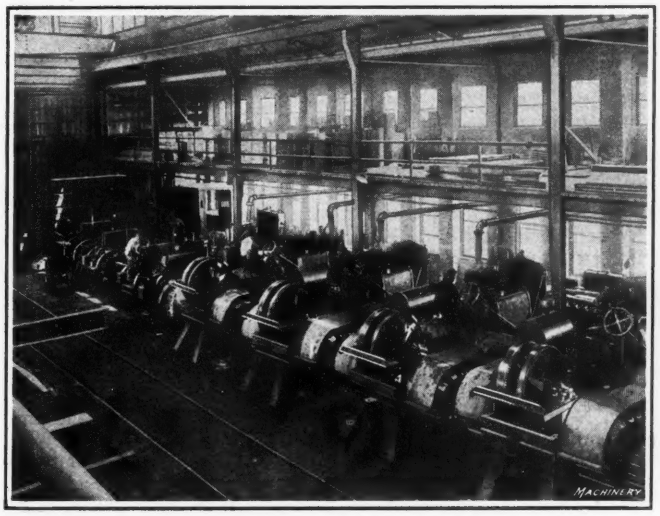

Fig. 17. Holt Caterpillar Tractors undergoing Shop Test on Blocks

Fig. 18. Seventy-five-horsepower Tractor, hauling Supply Train in Texas

Fig. 19. Seventy-five-horsepower Tractor crossing Deep Gully on Expedition

Fig. 20. Tractor at Bottom of Gully Ready to ascend Opposite Bank

Fig. 21. Holt Caterpillar having crossed Gully and ascended Opposite Bank

In view of the advantages of mechanical traction, particularly as shown in the European war, the United States Army has made an exhaustive study of the general problem of haulage and military supply trains. These tests began in 1915 and have steadily continued; they have included all the various field operations of the Quartermaster Corps, Engineers' Corps, light and heavy Field Artillery, Signal Corps, etc. Caterpillar tractors were found indispensable in building and maintaining roads for the motor truck trains during the expedition into Mexico in 1916; they are being used for hauling supply trains through the Big Bend District, Texas, where the troops guarding the Rio Grande boundary are from sixty to one hundred miles from the base of supply at Marfa. The Big Bend District consists principally of steep, rough mountain grades and desert roads. For the first time in the history of the United States Army, tractors were used in March, 1917, for hauling supplies in connection with marching troops. The initial trip was made from Fort Sam Houston to Laredo, a distance of 170 miles, where caterpillar 75-horsepower tractors accompanied the 37th Infantry, and after reaching Laredo, made the return to Fort Sam Houston with the 9th Infantry. It was necessary for the tractors at all times to maintain the speed of the marching regiment, so as to make camp each day on time with the regimental supplies. Although many severe road conditions were encountered, the tractors successfully met all requirements without mishap or breakage. Fig. 18 shows the supply train accompanying the 37th Infantry, consisting of fifteen Troy trailers, fourteen of which were of 1½ ton capacity and one of 3 tons capacity. The total weight of the trailers is 15 tons and of the cargo 30 tons, making a net hauling weight of 45 tons. One of the regular army escort wagons was later added, making the total hauling weight 53 tons. It would have required thirty army escort wagons with four mules each to handle this same tonnage.

Tractors are formidable in war, but they will achieve greater victories in times of peace. There is no doubt that agricultural work on large farms of the West and on many of the smaller farms of the East will eventually be done almost exclusively by means of tractors, and this, of course, applies also to agricultural work in all the countries of the world. The machine that has great pulling power, which can be used on soft soils and turn within its own length is at an advantage as compared with those requiring a large turning radius and firm soils to work efficiently for purely agricultural purposes. For long overland hauling, especially where bad roads exist, the caterpillar tractor has proved capable of hauling at a lower cost per ton mile than by other methods. For road hauling where greater speed is required and comparatively small tractive power is needed by reason of uniformly good roads, the four-wheel motor truck has some advantage, but no wheel vehicle can follow the caterpillar type tractor through muddy, sandy and rough roads or over steep grades or where no roads of any kind exist. F. E. R.

* * *

The by-products of the 48,000 sawmills in the United States, in the form of sawdust, shavings, slabs, etc., is estimated at 36,000,000 cords a year. About one-half of this is used as fuel, but the remaining 18,000,000 cords is a source of danger to the mill and requires the expenditure of time and money for its disposal. As the production of this waste is unavoidable, the forest service is seeking some way of turning it to account.

INDUSTRIAL EXPOSITION AND EXPORT CONFERENCE

The first annual Industrial Exposition and Export Conference of the allied industries of the United States was held at the Eastern States Exposition Grounds, Springfield, Mass., June 23 to 30. The purpose of this exposition and conference is to develop export opportunities for American manufacturers and to discuss problems incident to the supplying of foreign markets with American goods.

Thursday, June 28, was "Metals Day," and at the morning session, presided over by Charles E. Hildreth, general manager of the National Machine Tool Builders' Association, the following papers were presented:

"After the War—What of Machinery Export?" by C. O. Smith, Export Manager, Norton Grinding Co., Worcester, Mass.

"American Tools in Foreign Markets," by Oren O. Gallup, New York City Export Manager, Simonds Mfg. Co., Fitchburg, Mass.

"Metal Fittings in Overseas Markets," by Adolph W. Gilbert, Chapman Valve Mfg. Co., Indian Orchard, Mass.

At this session MACHINERY's motion picture, depicting the manufacture of 9.2-inch high-explosive howitzer shells, was shown, accompanied by an explanatory lecture by Chester L. Lucas of MACHINERY's staff.

In connection with the exposition there were interesting exhibits by 160 concerns, among whom were the following:

Bilton Machine Tool Co., Bridgeport, Conn. Gear-cutting machinery, sensitive drill presses, milling machines, and riveting machines.

Cowan Truck Co., Holyoke, Mass. Elevating electric and hand trucks, transportation systems.

Fitchburg Grinding Machine Co., Fitchburg, Mass. Grinding machines.

Peter A. Frasse & Co., Inc., Hartford, Conn. Tubing, steel, tools and supplies.

C. G. Garrigus Machine Co., Bristol, Conn. Machine tools.

General Electric Co., Schenectady, N. Y. Electrical apparatus.

Graton & Knight Mfg. Co., Worcester, Mass. Leather belting, leather specialties.

Greenfield Tap & Die Corporation, Greenfield, Mass. Screw cutting tools and machinery; gages, reamers, etc.

Hampden Corundum Wheel Co., Springfield, Mass. Grinding wheels and polishing abrasives.

Holyoke Truck Co., Holyoke, Mass. Transfer and elevating trucks.

Napier Saw Works, Inc., Springfield, Mass. Metal cutting saws and sawing machines.

National Scale Co., Chicopee Falls, Mass. Counting machines, calling system, elevating trucks, sectional steel shelving.

Noble & Westbrook Mfg. Co., Hartford, Conn. Marking and filing machinery, grinders and buffing lathes, steel dies.

Norton Co., Worcester, Mass. Grinding wheels, grinding machinery.

Norton Grinding Co., Worcester, Mass. Grinding wheels, grinding machinery.

Reed-Prentice Co., Worcester, Mass. Lathes, drilling machines, vertical surface grinding machines.

Springfield Grinding Co., Chester, Mass. Grinding wheels.

L. S. Starrett Co., Athol, Mass. Fine mechanical tools.

Union Twist Drill Co., Athol, Mass. Twist drills, gear and milling cutters.

Van Norman Machine Tool Co., Springfield, Mass. Machine tools, milling machines and grinders.

Walworth Mfg. Co., Boston, Mass. Valves, fittings and tools for steam, water and gas.

Whitcomb-Blaisdell Machine Tool Co., Worcester, Mass. Engine lathes and metal planers.

PYROMETERS OF THE PAST, PRESENT AND FUTURE[1]

A REVIEW OF DEVICES FOR MEASURING THE TEMPERATURE OF FURNACES, THEIR LIMITATIONS AND POSSIBLE FUTURE DEVELOPMENTS

As far as we know, the ancients, who baked excellent bricks and forged iron, measured temperature by a means still used today, but with ever-diminishing success—the eye. But at a very early date attempts were made to measure temperature by the expansion, contraction, or fusing points of clay. Even today the heat of brick and pottery kilns is determined by placing side by side, where they can be seen through a peep-hole, three cones with fusing points, for instance, of 2100, 2120 and 2140 degrees F. When the first cone softens and falls over, it indicates that a temperature of 2100 degrees F. has been attained, and the firing is stopped. If the other cones are still standing, the temperature has not exceeded 2120 degrees F. Unfortunately, though, the cones are affected by both time and temperature, and will soften or fall over at a higher temperature when heated up slowly for 100 hours than when heated to the softening point in an hour or two. They are not suitable for use in heat-treating furnaces for this reason, although attempts have been made to use them. However, some fusible salts have recently been brought out that seem to give reasonably satisfactory results. The capsules containing them are placed on a piece of steel in the furnace and the salts indicate, by melting, when a certain temperature has been attained.

Another of the early devices is the mercurial thermometer, with which everyone is familiar. For temperatures up to 600 degrees F., these have a vacuum above the mercury column. Thermometers graduated above 674 degrees must have the mercury column under pressure to prevent boiling; but 1000 degrees is about the limit for thermometers of this kind.

The first mechanical pyrometers depended on the difference in the expansion of iron and brass for their operation. This form of pyrometer has a tendency to change in its reading with time and temperature, due to the coefficient of expansion of the metals changing through continuous heating and cooling. This occasions frequent readjustments of the pointer to compensate for this error. Another early device was formed by placing a pipe in the furnace, through which water flowed under constant pressure. Thermometers at the inlet and outlet measured the temperature of the water, and the rise in temperature of the water was equivalent to a certain actual temperature in the furnace. The trouble with this device was that leaks occurred which it seemed impossible to prevent. The Siemens water pyrometer is used quite largely by armor-plate manufacturers for heat-treatment. It consists of a copper ball, which is placed on the steel in the furnace and left until it has fully attained the temperature, when it is quickly removed and dropped into a vessel containing a thermometer and a measured quantity of pure water. The rise in temperature of the thermometer in the water is read off in actual temperature degrees on a corresponding scale. An accuracy within about 25 degrees F. is usually attained with this instrument.

There have also been developed a number of pyrometers that compare either a light or different colors with the piece of steel in the furnace. The trouble with all of these is that no two operators get the same results. Resistance thermometers operate on the principle that the electrical resistance of metals changes with the temperature. This instrument is an exceedingly accurate one for measuring low temperatures, but is hardly to be recommended for high temperature service.

Thermo-electric Pyrometers

For measuring temperatures above 1000 degrees F., the thermo-electric method has come to be by far the most largely used. A thermo-electric pyrometer consists of a thermo-couple, a measuring device, and the wires connecting the thermo-couple and the measuring device. If two pieces of wire of different metals are joined at one end and the junction is heated, a small current of electricity will be generated. At 2000 degrees F., a couple formed of iron and copper-nickel wires will generate 50 millivolts. For measuring temperatures up to 200 degrees F., a thermo-couple of bismuth and antimony is best; for temperatures up to 1000 degrees F., a satisfactory thermo-couple consists of one iron wire and one 60 per cent nickel and 40 per cent copper; for temperatures as high as 1800 degrees F., a very satisfactory base-metal thermo-couple is one wire of 90 per cent nickel and 10 per cent chromium and the other wire of 98 per cent nickel and 2 per cent aluminum. For constant service above this, a thermo-couple, one wire of which is chemically pure platinum and the other 90 per cent platinum and 10 per cent rhodium, is recommended.

Thermo-couples of base metal are manufactured with wires from 0.01 inch up to 0.25 inch diameter. Some particular tests require thermo-couple wires of exceedingly small diameter to secure sensitiveness and quick readings. There is no doubt but that heavier wires forming the thermo-couple will increase the life where a base-metal thermo-couple is in constant service at temperatures up to 1600 or 1800 degrees F. While a heavier thermo-couple slightly increases the lag, this is not noticeable in heat-treating furnaces.

If after a base-metal thermo-couple has been used for some time another couple is made from the same wires, the voltage produced might vary as much as 50 degrees at a temperature of 1400 degrees F. Thermo-couples of nickel-chromium wire will vary as much as 30 degrees F., that is, 15 degrees plus or minus, depending on the particular coils from which the wire was cut.

The wires forming a thermo-couple must be insulated from each other throughout their length. A common method is to wrap base-metal thermo-couples with asbestos and paint the asbestos winding with a solution of sodium silicate; another method is to fit lava or porcelain beads over the thermo-couple wire. For the platinum thermo-couple, the insulation must be of porcelain or high-grade fireclay, free from impurities.

The life of a thermo-couple installed in a furnace largely depends on its protecting tube. For temperatures up to 1200 degrees F., a high-grade wrought-iron tube gives satisfactory results. Calorizing, a process recently developed by the General Electric Co., which impregnates the pipe with an aluminum oxide, will increase the life of the pipe about three times when used at temperatures around 1400 degrees F. Tubes of nickel-chromium give excellent results for temperatures as high as 1800 degrees, and they are to be recommended for the protection of base-metal thermo-couples where the temperature exceeds 1200 degrees. Their cost is many times higher than the ordinary wrought-iron pipe and about four times as much as calorized pipe, but their increased life would justify the increased first cost. Platinum thermo-couples must always be protected with a tube that is impervious to gases, such as porcelain, quartz, or alundum.

It is one of the properties of a thermo-couple that the voltage which it generates is dependent on the difference in the temperature of the hot junction and the cold junction, which is the point at which the alloy wires of the thermo-couple join the copper leads of the instrument. It is therefore particularly important that the cold junction be maintained at a constant temperature. In recent years, it has been customary to run compensating leads of the same material as the thermo-couple to a distant point, where the temperature is uniform, instead of having the cold junction just outside the furnace wall, where it might vary several hundred degrees. These compensating leads, in duplex form with asbestos insulation, can be run into a pipe driven into the ground, ten or fifteen feet, where the temperature will remain constant within five degrees, winter or summer. Where it is impossible to place the cold junction in the ground, on account of the furnaces being on an upper floor of a building, a compensation

[1]Abstract of a paper by Richard P. Brown, read before the Steel Treating Research Club of Detroit, Mich.

box can be used, consisting of a lamp and thermostat, which will maintain the temperature constant within two degrees.

Measuring Voltage Produced by Thermo-couple

There are two methods of measuring the voltage produced by a thermo-couple, the millivoltmeter method and the potentiometer method. In the former, the instrument consists of a permanent magnet with its pole pieces, in the field of which a copper-wound coil swings in jeweled bearings. The millivoltmeter reads the temperature across the scale and is calibrated in actual temperature degrees. It indicates the temperature from zero to the maximum scale range and relies entirely on the voltage of the thermo-couple for its operation. No outside sources of current are necessary.

In the potentiometer method, the electromotive force produced by the thermo-couple is measured by opposing to it a known variable electromotive force, usually that of a dry cell contained in the instrument, so that when a balance is reached no current flows. A galvanometer is used to indicate the point at which no current is flowing, and the pointer on the galvanometer then indicates zero as the voltage of the thermo-couple is opposed to the dry cell. The advantages of the potentiometer method of measuring temperature are its extreme precision and its independence of resistance changes throughout the thermo-couple circuit. Its disadvantages are that it is not direct reading and some outside source of current is necessary.

Radiation Pyrometers

The radiation pyrometer is a development of the thermo-electric pyrometer. Instead of placing the thermo-couple inside the furnace, where the temperature is so high as to destroy it, it is placed in the back of a tube in front of a mirror. The rays of heat from the furnace enter the tube and, striking the mirror, are brought to a focus on the thermo-couple junction, which attains a heat of only 200 or 300 degrees. It is possible to secure an accuracy within one to two per cent with this instrument, if the instructions for its use are properly carried out. It is not recommended for service where a thermo-electric pyrometer with a base-metal or platinum thermo-couple can be used.

Methods of Standardizing Pyrometers

It is essential, if accurate results are to be secured from pyrometers, that they be restandardized at frequent intervals. The frequency depends on the precision necessary in the work and the equipment available. Some plants check their thermo-couples once a week; it should be done at least once a month. This checking can be satisfactorily accomplished by maintaining a standard platinum thermo-couple and using an electric furnace that is not less than 10 inches deep, so that a base-metal thermo-couple can project at least 6 or 8 inches inside. The base-metal and standard thermo-couples should be tied together with asbestos string with the junctions almost touching each other. Thermo-couples should never be tested in their protecting pipe. A base-metal thermo-couple should not be tested in a furnace with an insertion of less than 6 inches, for the cross-section of the thermo-couple wires is large and they conduct the heat from the furnace. The temperature of an electric furnace should be maintained constant for at least fifteen minutes before a reading is taken, and the tests should preferably be made at the working temperature of the thermo-couple. If the thermo-couple under test reads low and has no adjustable resistance, it must be junked. If it is furnished with a resistance for adjustment purposes, this adjustment can be easily made with a soldering iron.

The freezing point of pure salt is reliable for testing thermo-couples or the complete pyrometer. The thermo-couple should be inserted in a small crucible containing pure salt (ordinary table salt is satisfactory), heated to about 1600 degrees F. and then allowed to cool. At the freezing point of the salt, which will be indicated by the temperature remaining reasonably constant for four or five minutes, the pyrometer should read 1474 degrees. The melting point of a number of metals may also be used. The melting points of the metals most generally used for this purpose are: tin, 450 degrees F.; zinc, 787 degrees; silver, 1761 degrees; and gold, 1945 degrees.

The Future for Pyrometry

It would seem that the greatest development work in temperature-measuring instruments will be in the perfection of optical pyrometers, resistance thermometers, and thermo-electric pyrometers. There is a field for a high-grade optical pyrometer that can be used by any number of operators, all of whom can secure the same results from the instrument. Resistance thermometry will continue to be limited to low temperatures unless some more suitable metal than nickel can be used to form the bulbs. In thermo-electric pyrometry, it is possible to develop better materials for base-metal thermo-couples; the insulation or protecting tube will be difficult to improve upon. The direct-reading millivoltmeter and the potentiometer methods of temperature measurement will doubtless be improved.

However, the greatest future in pyrometry will be along the line of automatic temperature control. There is already an instrument that automatically controls the temperature of an electric furnace, maintaining it constant within 10 degrees F. In connection with this instrument, there are two lights which indicate whether the temperature is high or low. We can place a neutral point, 10 or 20 degrees in width, between the two contact points operating these lights, so that both lights will be out when the temperature is correct and the red or blue light will flash to indicate that the temperature is too high or too low. If a third contact is put in the instrument for this neutral point, it will cause a white light to glow when the temperature is correct. It is much easier to instruct a fireman to keep the white light burning and the other lights out than to get him to maintain 1380 degrees on the pyrometer. He can see the lights from some distance, and these are easily understood by him. It is only a question of time when a switching device will permit one instrument to operate the signal lights at a number of furnaces.

One of the greatest difficulties experienced by pyrometer manufacturers is to induce the user of these instruments to install them properly. Frequently this is left to someone who has absolutely no knowledge of pyrometers, and the instructions of the manufacturer are not carried out in a satisfactory manner. Recently, the service man of one pyrometer company found pyrometer equipment giving incorrect readings because it had been wired up throughout with small diameter uninsulated iron wire.

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MILLING AND GRINDING

The use of milling machines and grinding machines has increased greatly during the past ten years, and these machines are now regarded generally as standard machine tool equipment. There is little question of the superiority of the milling machine over the planer or shaper for manufacturing parts in large quantities. Nor can the place of the grinding machine as a follower of the lathe for finishing cylindrical surfaces be longer denied. But notwithstanding the great increase in the use of these machine tools, the lathe is still the recognized leader of all. More lathes are built and sold than any other machine tool except drilling machines. Planers have their place in the machine shop and will always be used for jobbing and repair work and probably for planing the working surfaces of machines that must be highly accurate. The shaper and slotter have their recognized places also. The point to be made is that the development of any type of machine tool does not necessarily, if ever, result in displacing another; it may, in fact, make a broader and better market for all.

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FOUNDRY AND MACHINE SHOP EQUIPMENT AND SUPPLIES EXHIBIT

The twelfth annual exhibit of foundry and machine shop equipment and supplies will be held in the Mechanics Bldg., Boston, Mass., under the auspices of the American Foundrymen's Association, September 25 to 28, inclusive. Copies of the rules and regulations may be obtained from C. E. Hoyt, manager of exhibits, 123 W. Madison St., Chicago, Ill.

MACHINE-CUT ELLIPTICAL GEARS[1]

LAYING OUT AND MACHINING ELLIPTIC AND OVAL GEARS

BY REGINALD TRAUTSCHOLD[2]

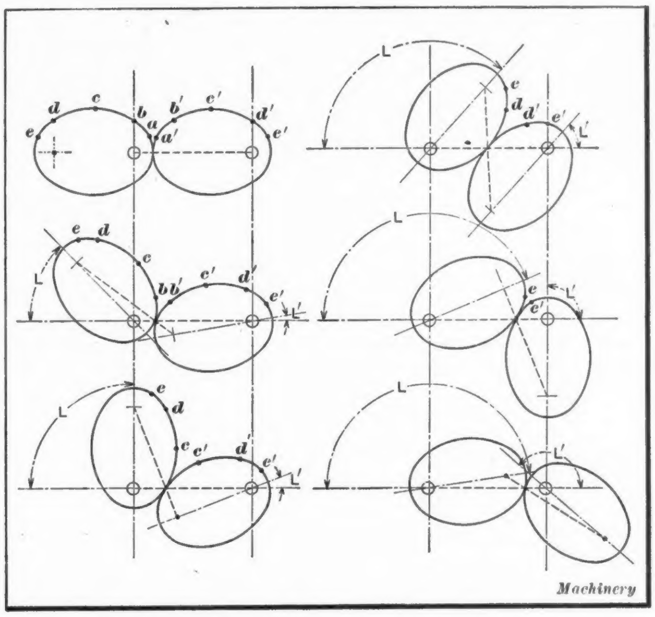


Fig. 1. Rolling Contact of Ellipses with Bore at Focus

THE correct proportioning of elliptic or elliptical gearing presents one of the most intricate problems confronting the gear designer, but, fortunately, it need not present the same difficulties to the machinist if the work is correctly laid out for him in the drafting-room. To cut elliptic gears successfully requires a high degree of skill and careful workmanship on the part of the machine operator, but the real problem is one of design. This is fortunate, for it permits the derivation of reliable formulas which, though they necessitate considerable accurate figuring on the part of the designer, greatly simplify the calculations and enable the problem to be put to the operator as a definite and concrete task: one that requires, in its execution, simply careful workmanship and proper attention to the adjustments of a comparatively simple fixture.

Elliptic gearing furnishes a comparatively cheap, efficient and positive mechanism for imparting a quick-return motion to the ram of shapers, planers and a large variety of machine tools. The variation in speed of these gears is from a maximum to a minimum, the bore being located at one of the foci of the ellipse. So-called "elliptical" gears with the bore at the center of the gear are also employed. These have not a true elliptic outline, but their circumference is appreciably greater than is that of a true ellipse of similar major and minor axes. To differentiate it from the one of true elliptic outline, this second variety of gear may be arbitrarily designated as an "oval gear"; while the term elliptic gear may be taken to designate a gear of true elliptic form.

The rolling actions of the two forms of mountings, those with the bore at the foci and those with the bore at the center, are depicted in Figs. 1 and 2. In the case of ellipses with the bore at one of the foci, any point on the circumference of one of the ellipses, *a*, *b*, *c*, *d*, *e*, will be in contact with any similarly located point on the circumference of the other ellipse, *a'*, *b'*, *c'*, *d'*, *e'*, in the plane of the bores and a line connecting the stationary foci of the two ellipses will lie in this plane and intersect a plane tangent to both ellipses at the point of contact. In the case of the ellipses with the bore at the center, points on the circumference of one of the ellipses, *a*, *b*, *c*, *d*, *e*, will not be in contact with similarly located points on the circumference of the other ellipse, *a'*, *b'*, *c'*, *d'*, *e'*, on the bore plane, the centers of the bores being fixed as in the other instance, but will be separated by an amount depending on the proportions of the ellipses. Only when the major and minor axes of the ellipses are at right angles can the ellipses be in intimate contact. To secure contact at all points, the elliptic outlines must be increased by an increment that will fill in the gap between the ellipses; and in order that the two figures may be similar in outline, the increment should be the same for each ellipse.

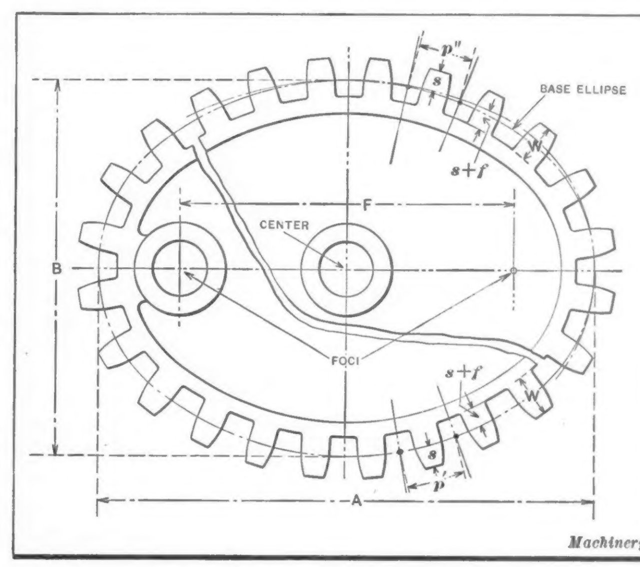


Fig. 3. Elliptic and Oval Gear Diagrams

The similarity between elliptic and oval gears lies only in the fact that they are both developed from ellipses. In one case the ellipse is the final outline; and in the other, the ellipse has to be modified by an increase in the length of curve included between the two axes' planes in each of the four quadrants. The lengths of the axes are not changed, nor should the degree of curvature at points of contact be altered; the variation in curvature is simply limited to sections between the required points of contact. Elliptic and oval gear sections are illustrated in Fig. 3 in a manner that brings out their similarity in general appearance as well as their difference in pitch outlines.

The Ellipse

The basic form of either the elliptic or the oval gear is the ellipse, so the characteristics of this figure should be clearly

[1] For previous articles on the design of gearing, see "Epicyclic Gear Trains" in the July, 1917, number of MACHINERY, and articles there referred to.
[2] Address: 39 Charles St., New York City.

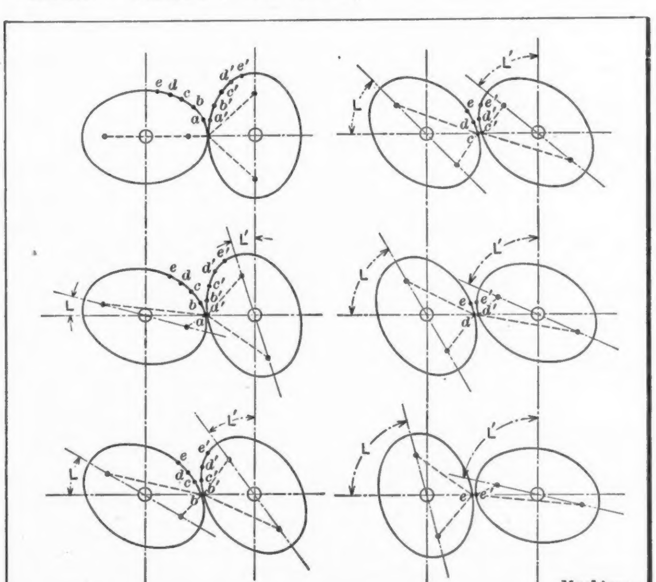


Fig. 2. Non-contact of Ellipses with Bore at Center

understood before taking up the derivation of working formulas. An ellipse is shown in Fig. 4. Its governing peculiarity is that the sum of the distances of any point *P* on the circumference from the two foci is constant, and the normal passing through such point bisects the angle included between lines drawn from the point to the foci. The angle between the tangent to the point and one of the axes of the ellipse is equal to the angle between the normal to the point and the other axis of the ellipse. The distance between the two foci, the "focus distance," is equal to the square root of the difference of the squares of the major and minor axes. These definite relations establish the equation of the ellipse, which, though simple, necessitates an application of analytical geometry and calculus to establish the location of any particular point on the circumference, the angularity of tangents, etc. This involves much calculation that, from a practical point of view, is quite unnecessary.

The curvature of an ellipse really decreases in each quadrant, from the major to the minor axis, but for all practical purposes, there are but two degrees of curvature in each quadrant of any elliptic gear encountered in practice, or that is capable of practical use, so that a close approximation of a true ellipse may be drawn with circular arcs of but two radii. These radii, which, for convenience, will be designated as major and minor, are equal to the major axis minus one-half the minor axis and to three-quarters the minor axis minus one-quarter the major axis. The first is the radius of the curve straddling the minor axis, and the second is the radius of the curve straddling the major axis. In workable ellipses, such curves become tangent to each other at definite points, so that the length of the major-radius curve is an arc included by an angle of 73 degrees, 44 minutes, as shown in Fig. 4, and the minor-radius curve is an arc included by an angle of 106 degrees, 16 minutes. These angles may be arbitrarily taken as the same for all ellipses, irrespective of the axes' lengths.

Dimensions Required by the Machinist

Fig. 5 depicts the method of cutting both elliptic and oval gears, the rotary cutter being tangent to the pitch line at mid-tooth space. The angle of tangency, the angle included between the center line of the rotary cutter and the major axis, is the same for either type of gear, but the location of the bore in respect to the center line of the cutter differs. If the outlines of the two varieties of gears were similar, the difference in both vertical and horizontal coordinates would be controlled by the distance from the focus to the center of the gear. In fact, much of the trouble encountered in cutting oval gears with the bore at the center comes from just this particular point. Oval gears with the bore at the center are not elliptic in outline and cannot be successfully cut with settings that would be satisfactory were it not necessary to modify the elliptic form in order that the gears may roll together in intimate contact.

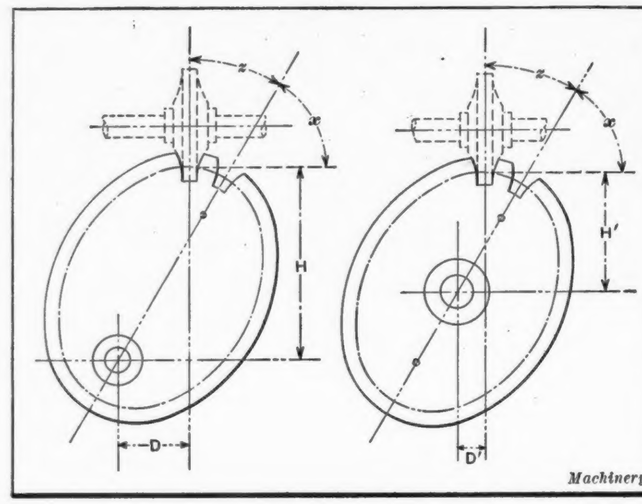


Fig. 5. Machining Elliptic and Oval Gears

Laying Out Elliptic Gears

The elliptic gear is the simpler variety to design, as an oval gear must first be proportioned as if it were truly elliptic in outline and then modified by the necessary increments. Both varieties are frequently laid out to a suitable scale and the required dimensions scaled; the "lay-out method" and a certain dependence on graphic depiction is a material aid even when employing the more accurate method of calculation of the necessary angles and dimensions.

The pitch outline of an elliptic gear is shown in Fig. 6. This may be drawn by the common "gardener's ellipse" method or by the use of the circular arcs, as has been described. The pitch circumference is then divided into as many equal sections as there are teeth in the gear, the points of division locating the centers of the tooth spaces. Preferably, the number of teeth in an elliptic gear should be odd, so that a tooth space at one end of the gear is opposite a tooth at the other end, thereby permitting both gears of a pair to be identical. If the number of teeth is even, a double set of calculations becomes necessary, as the tooth spaces of one of a pair must coincide with the teeth of the mating gear.

The coordinates of the center of the tooth spaces, with reference to the stationary focus, are readily calculated for an ellipse laid out with circular arcs, and are, for all practical purposes, the same as those of similar points about a true ellipse. The distance of each tooth-space center from the stationary focus is then readily obtained, as it is the length of the hypotenuse of a right-angle triangle having for its other sides the coordinates of the tooth-space center with respect to the stationary focus. These coordinate dimensions are the horizontal and vertical settings required by the machinist, and the angular setting of the blank is the angle included between the tangent at mid-tooth space and the major axis of the ellipse.

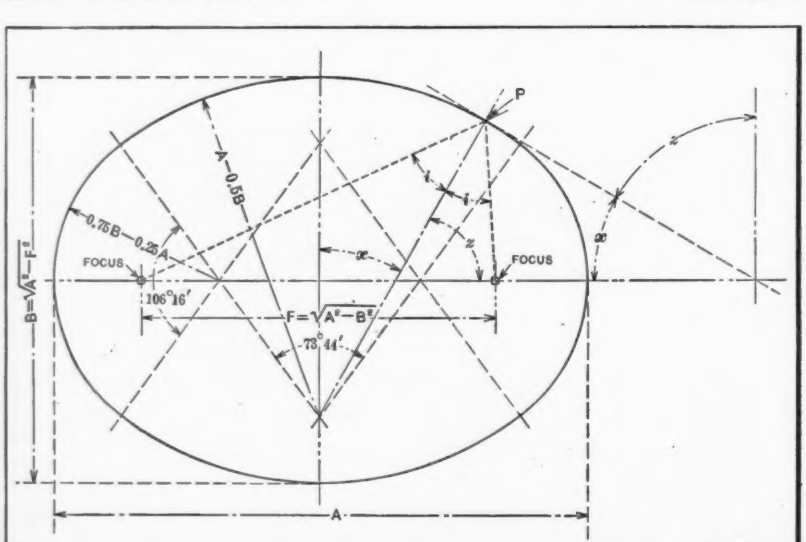


Fig. 4. The Ellipse

Laying Out Oval Gears

Oval gears should have an even number of teeth, so that but one set of calculations is necessary, and the teeth should be arranged so that they do not come on the axis of the ellipse, but so that the transverse pitch line on the profile of a tooth falls on the axes of the gear, as shown in Fig. 7. This illustration depicts the basic oval outline of the gear, not its final pitch outline.

The coordinates of the tooth-space centers, with reference to the center of the gear, are found in a manner similar to that employed for elliptic gears. The distance of each tooth-space center from the center of the gear on the base ellipse is then found and normals through each of the tooth-space centers are drawn. The horizontal setting *D'* is found directly from the triangle formed by the line connecting the center tooth space on the ellipse and the rectangular

coordinates of such point about the center of the gear. The ordinate of the point is also calculated, though it is not equal to the vertical setting, which is controlled by the amount of increment added to the ellipse at each tooth space.

The distance between shafts of mating oval gears is constant and equal to one-half the sum of the major and minor axes of the gear, so that if the sum of the distances from the tooth-space center of conjugate tooth spaces is made equal to the distance between shafts, constant contact is secured. The proper total increment required in order to secure such intimate contact between mating gears is the difference between the sum of the distances of center tooth points on the ellipse of conjugate tooth spaces and the distance between the shafts of the respective gears. Half of this total increment added to each gear will keep the gears similar in outline. The increment is not added to the oval outline normally, but so that the distance from the pitch center of the tooth space on the mid-tooth space normal to the center of the gear is equal to the distance from the center of the gear to the center of the tooth space on the ellipse, plus half the total increment required for intimate contact, see Fig. 8. A smooth curve passing through the points thus located on the tooth space normals gives the required pitch outline of the gear. To this must be added, in the gear blank, sufficient metal to accommodate the addendum of the teeth, etc. The correct vertical setting is then obtained by direct proportion, the same relationship existing between the distance of the mid-tooth space point on the ellipse and this same dimension plus the necessary increment as exists between the ordinate of the center tooth space on the ellipse and the correct vertical setting.

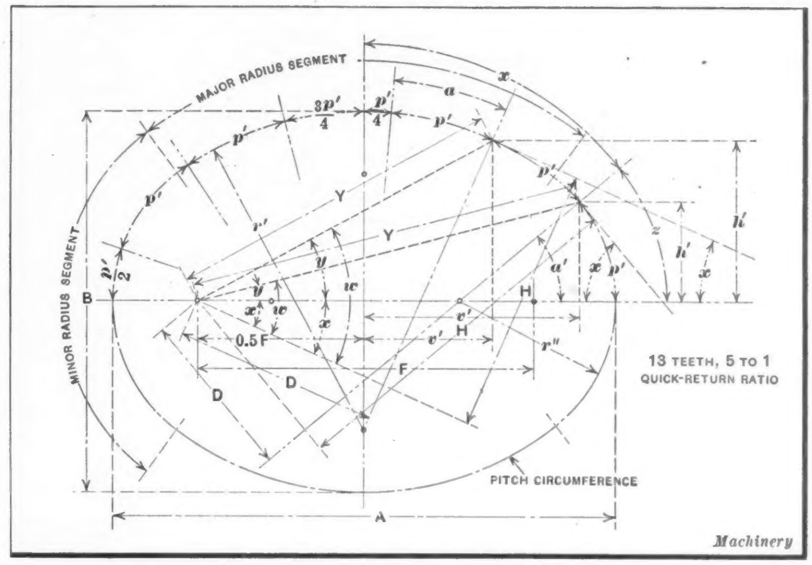


Fig. 6. Elliptic Gear Diagram

$$v' = r'' \cos z + 0.5A - r'' \quad \text{(in minor-radius segments)} \qquad (11)$$

$$v' = r' \sin x \quad \text{(in major-radius segments)} \qquad (11a)$$

$$Y = \sqrt{h'^2 + (\pm 0.5F \pm v')^2} \quad (12) \qquad \operatorname{Tan} y = \frac{h'}{\pm 0.5F \pm v'} \quad (13)$$

$$w = y \pm x \quad (14) \qquad H = Y \sin w \quad (15)$$

$$D = Y \cos w \quad (16) \qquad p'' = \frac{C}{N} \quad (17)$$

$$Y'' = \sqrt{h'^2 + v'^2} \quad (18) \qquad j = 0.5(0.5A + 0.5B - X) \quad (19)$$

$$Y' = Y'' + j \quad (20) \qquad \operatorname{Tan} y' = \frac{h'}{v'} \quad (21) \qquad w' = y' + x \quad (22)$$

$$H'' = r'' + (0.5A - r'') \cos (90 - x) \quad \text{(in minor-radius segments)} \qquad (23)$$

$$H'' = Y'' \sin w' \quad \text{(in major-radius segments)} \qquad (23a)$$

$$H' = \frac{H''Y'}{Y''} \qquad (24)$$

$$D' = (0.5A - r'') \sin (90 - x) \quad \text{(in minor-radius segments)} \qquad (25)$$

$$D' = Y'' \cos w' \quad \text{(in major-radius segments)} \qquad (25a)$$

Notation for Elliptical Gearing

Major axis (pitch)	A
Minor axis (pitch)	B
Focus distance, distance between foci	F
Pitch circumference of ellipse	C
Quick-return ratio of elliptic gears	R
Number of teeth	N
Circular pitch of elliptic gears	p'
Major radius for ellipse	r'
Minor radius for ellipse	r''
Angular pitch of major radius segment	a
Angular pitch of minor radius segment	a'
Angle included between tooth-space tangents and major axis	x
Angularity of ratchet index	z
Ordinate of tooth-space center on ellipse	h'
Abscissa of tooth-space center on ellipse	v'
Distance between tooth-space center on ellipse and focus axis	Y
Angle included between Y and major axis	y
Angle included between Y and tooth-space tangent	w
Vertical setting for machining fixture	H
Horizontal setting for machining fixture	D
Effective circular pitch of oval gears	p''
Distance between tooth-space center on ellipse and gear center	Y''
Sum of conjugate Y''	X
Correction increment	j
Distance between tooth-space pitch center and gear center	Y'
Angle included between Y'' and major axis	y'
Angle included between Y'' and tooth-space tangent	w'
Vertical setting on ellipse	H''
Vertical setting for machining fixture	H'
Horizontal setting for machining fixture	D'

Formulas for Elliptic and Oval Gears

$$B = \sqrt{A^2 - F^2} \quad (1) \qquad F = \frac{A(R-1)}{R+1} \quad (2)$$

$$R = \frac{A+F}{A-F} \quad (3) \qquad r' = A - 0.5B \quad (4)$$

$$r'' = 0.75B - 0.25A \quad (5) \qquad C = 1.6464A + 1.4952B \quad (6)$$

$$p' = \frac{C}{N} \quad (7) \qquad a = \frac{57.295p'}{r'} \quad (8) \qquad a' = \frac{57.295p'}{r''} \quad (9)$$

$$h' = r'' \sin z \quad \text{(in minor-radius segments)} \qquad (10)$$

$$h' = r' \cos x - r' + 0.5B \quad \text{(in major-radius segments)} \qquad (10a)$$

Discussion of Formulas

The relationships existing between the major axis, the minor axis, and the focus distance are the ordinary characteristics common to the ellipse. The quick-return ratio of elliptic gears is the ratio between the maximum and minimum distances of the pitch circumference from the stationary, or bore, focus. No such ratio exists for oval gears, as the distance between the shafts of the gears with the central bore is equal to half the sum of the major and the minor axes. Two speed changes occur during a complete revolution of the gears in such an arrangement; one is measured by the ratio of the major axis to the minor axis, and the other by the ratio of the minor axis to the major axis.

The major and minor radii of the ellipse are the radii of circular arcs straddling the minor and the major axes, respectively; the former contains 73 degrees, 44 minutes, and the latter 106 degrees, 16 minutes. The sum of the lengths of the two major-radius segments and the two minor-radius segments equals the circumference of the ellipse. This divided by the number of teeth gives the circular pitch for elliptic gears.

The circular pitch multiplied by 360 degrees and the product divided by the circumference of a circle having a radius equal to the major radius of the ellipse gives the angular pitch in the major-radius segments. The same product divided by the circumference of a circle having a radius equal to the minor radius of the ellipse gives the angular pitch in the minor-radius segments.

To obtain the ordinate of the tooth-space center on the pitch ellipse necessitates two formulas: one for cases where the tooth-space center falls within the minor-radius segments, and

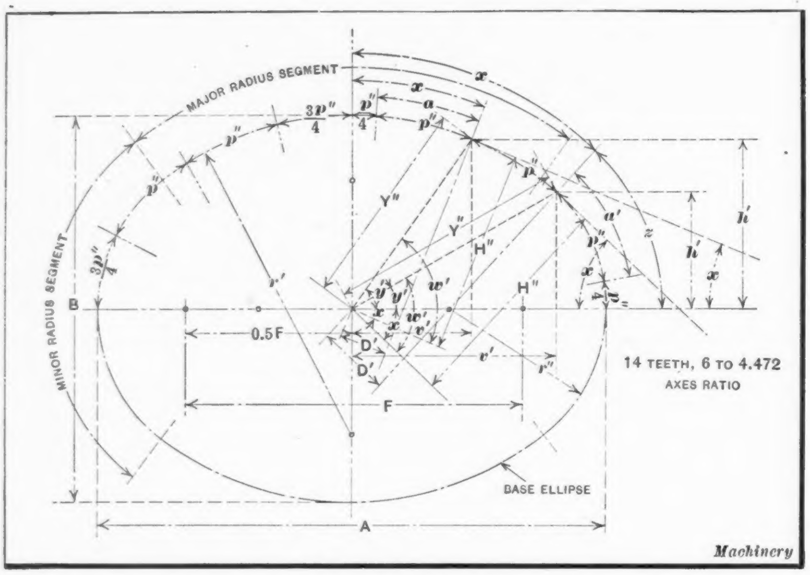


Fig. 7. Base Ellipse for Oval Gear

the other for points that fall within the major-radius segments. In the former, the ordinates are equal to the minor radius times the sine of the angle included between the normal passing through the tooth-space center and the major axis. Within the major-radius segments, the ordinates are measured by the product of the major radius and the cosine of the angle included between the normal passing through the tooth-space center and the minor axis, minus the difference between the major radius and one-half the minor axis. This value, by which the product of the major radius and the cosine of the angle is reduced, is the distance from the major axis to the center of the major radius.

The abscissa of the tooth-space center on the pitch ellipse is found in a similar manner, two formulas being required. For centers within the minor-radius segments, the abscissas are equal to the product of the minor radius and the cosine of the angle included between the normal passing through the tooth-space center and the major axes, plus the difference between half the major axis and the minor radius. Within the major-radius segments, the abscissas are equal to the major radius multiplied by the sine of the angle included between the normal passing through the tooth-space center and the minor axis.

The distance between the tooth-space center on the ellipse and the stationary focus in elliptic gears is equal to the square root of the sum of the square of the ordinate plus the square of the distance of the projected center on the major axis from the stationary focus. When the projection of the center on the major axis falls on the farther side of the minor axis from that on which the stationary focus is located, this distance is equal to one-half the focus distance plus the abscissa; when between the near center of the minor radius and the minor axis, it is equal to the focus distance minus the abscissa; and when between the near minor radius center and the near end of the major axis, it is equal to the abscissa minus half the focus distance.

The tangent of the angle included between Y and the major axis is equal to the ordinate of the tooth-space center divided by the distance of the projected center on the major axis from the stationary focus. This angle plus or minus the angle included between the tangent to the tooth-space center and the major axis equals the angle included between Y and the tooth-space tangent. When the tooth-space center lies on the far side of the minor axis, the angle included between Y and the tooth-space tangent is the sum of the two smaller angles; when on the near side, it is equal to the difference of the two angles.

The vertical setting for the machining fixture, the distance between the plane of the rotary cutter and a parallel plane passing through the stationary focus of the gear, is equal to the distance between the tooth-space center and the stationary focus multiplied by the sine of the angle included between Y and the tooth-space tangent; while the horizontal setting for the machining fixture is equal to the product of this same dimension by the cosine of the angle.

The effective circular pitch of oval gears corresponds to the circular pitch of elliptic gears and is found in the same manner; namely, by dividing the pitch circumference of the base ellipse by the number of teeth in the gear.

The distance between the center of the tooth space on the ellipse and the central bore of the gear is equal to the square root of the sum of the squares of the ordinate and abscissa dimensions of the tooth-space center on the base ellipse.

The correction increment is equal to half the sum of the major and minor axes of the gear, minus the sum of the distances of conjugate tooth-space centers on the base ellipse from the center of the gear divided by 2. Conjugate tooth spaces are a tooth space on one gear and the space opposite the tooth on the mating gear that will engage the tooth space on the first gear. For instance, in a pair of mating oval gears with fourteen teeth, the conjugate tooth space of the first tooth space on the driving gear is the fourth tooth space on the driven gear, counting tooth spaces from similar points on the two gears. Similarly, the conjugate tooth space for the second tooth space on the driver is the third on the driven gear, and for the remainder of the tooth spaces the conjugates are the third and second, fourth and first, fifth and fourteenth, sixth and thirteenth, seventh and twelfth, eighth and eleventh, ninth and tenth, tenth and ninth, and so forth.

The correction increment added to the distance between the tooth-space center on the base ellipse and the central bore gives the distance of the actual pitch center of the tooth space from the center of the gear.

The tangent of the angle included between the line connecting the tooth-space center on the base ellipse with the center of the gear and the major axis is equal to the ordinate dimension of the point on the base ellipse divided by its abscissa dimension. This angle plus the angle included between the tooth-space normal and the minor axis (the complement of the angle included between the tooth-space normal and the major axis) equals the angle included between Y'' and the tooth-space tangent on the base ellipse.

The vertical setting on the base ellipse, when the normal of the tooth space crosses the minor-radius segment of the base ellipse, is equal to the minor radius plus the product of the cosine of the complement of the angle included between the

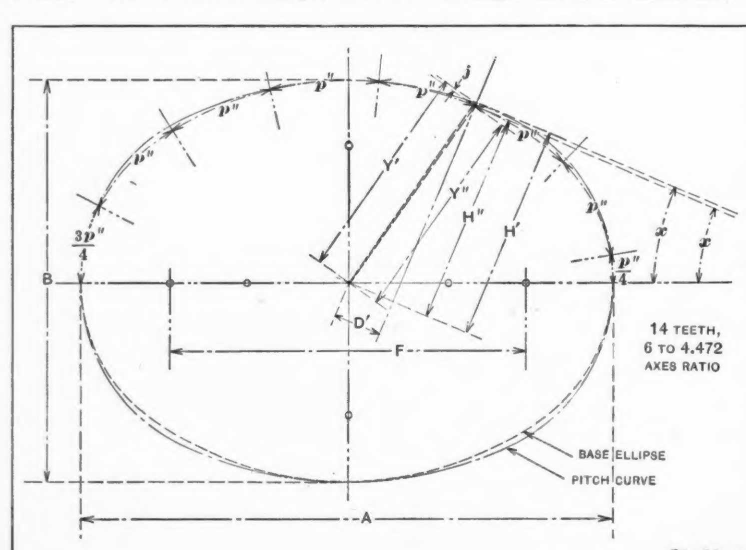


Fig. 8. Oval Gear Diagram

tooth-space tangent and the major axis by the difference between half the major axis and the minor radius of the base ellipse. When the tooth-space normal crosses the major-radius segment, the vertical setting on the base ellipse is equal to the product of Y'' by the sine of the angle included between Y'' and the tooth-space tangent.

The vertical setting on the base ellipse multiplied by the quotient of Y' divided by Y'' equals the vertical setting for the machining fixture. This dimension is the distance between a tangent to the pitch curve at the tooth-space normal and a parallel line passing through the central bore of the gear.

The horizontal setting for the machining fixture, in minor-radius segments, is equal to the product of the sine of the complement of the angle included between the tooth-space tangent and the major axis by the difference between half the major axis and the minor radius of the base ellipse. The horizontal setting for tooth spaces crossing the major-radius segment is equal to the product of Y'' by the cosine of the angle included between Y'' and the tooth-space tangent. For tooth spaces lying to the right of the gear center, the horizontal settings are also measured to the right; and for tooth spaces lying to the left of the gear center, the horizontal settings are in the same direction.

Example 1—Required, a pair of elliptic gears; 6-inch centers, 5 to 1 quick-return motion, 13 teeth; bore at focus.

$$F = \frac{6(5-1)}{5+1} = 4 \text{ inches} \quad (2)$$

$$B = \sqrt{36-16} = 4.472 \text{ inches} \quad (1)$$

$$C = 1.6464 \times 6 + 1.4952 \times 4.472 = 16.5649 \text{ inches} \quad (6)$$

$$p' = \frac{16.5649}{13} = 1.2742 \text{ inch} \quad (7)$$

$$r' = 6 - 0.5 \times 4.472 = 3.764 \text{ inches} \quad (4)$$

$$r'' = 0.75 \times 4.472 - 0.25 \times 6 = 1.854 \text{ inch} \quad (5)$$

$$a = \frac{57.295 \times 1.2742}{3.764} = 19.396 \text{ degrees} \quad (8)$$

$$a' = \frac{57.295 \times 1.2742}{1.854} = 39.377 \text{ degrees} \quad (9)$$

Tooth-space Number	x, Degrees	z, Degrees	Tooth-space Number	x, Degrees	z, Degrees
1	90.000	0.000	8	70.312	199.688
2	50.623	39.377	9	33.943	236.057
3	24.245	65.755	10	14.547	255.453
4	4.849	85.151	11	4.849	274.849
5	14.547	104.547	12	24.245	294.245
6	33.943	123.943	13	50.623	320.623
7	70.312	160.312			

Tooth-space Number		
1	$h' = 0.000$ inch	
2	$h' = 1.854 \times 0.63451 = 1.175$ inch	(10)
3	$h' = 3.764 \times 0.91176 - 1.528 = 1.902$ inch	(10a)
4	$h' = 3.764 \times 0.99642 - 1.528 = 2.227$ inches	(10a)
5	$h' = 3.764 \times 0.96793 - 1.528 = 2.114$ inches	(10a)
6	$h' = 3.764 \times 0.82960 - 1.528 = 1.592$ inch	(10a)
7	$h' = 1.854 \times 0.33682 = 0.625$ inch	(10)
8	$h' = 0.625$ inch	
9	$h' = 1.592$ inch	
10	$h' = 2.114$ inches	
11	$h' = 2.227$ inches	
12	$h' = 1.902$ inch	
13	$h' = 1.175$ inch	

Tooth-space Number		
1	$v' = 3.000$ inches	
2	$v' = 1.854 \times 0.77292 + 1.146 = 2.578$ inches	(11)
3	$v' = 3.764 \times 0.41072 = 1.549$ inch	(11a)
4	$v' = 3.764 \times 0.08455 = 0.318$ inch	(11a)
5	$v' = 3.764 \times 0.25122 = 0.947$ inch	(11a)
6	$v' = 3.764 \times 0.55830 = 2.106$ inches	(11a)
7	$v' = 1.854 \times 0.94157 + 1.146 = 2.890$ inches	(11)
8	$v' = 2.890$ inches	
9	$v' = 2.106$ inches	
10	$v' = 0.947$ inch	
11	$v' = 0.318$ inch	
12	$v' = 1.549$ inch	
13	$v' = 2.578$ inches	

Tooth-space Number		
1	$Y = 0.5 \times 4 + 0.5 \times 6 = 5.00$ inches	
2	$Y = \sqrt{(1.175)^2 + (2 + 2.578)^2} = 4.72$ inches	(12)
3	$Y = \sqrt{(1.902)^2 + (2 + 1.549)^2} = 4.03$ inches	(12)
4	$Y = \sqrt{(2.227)^2 + (2 + 0.318)^2} = 3.22$ inches	(12)
5	$Y = \sqrt{(2.114)^2 + (2 - 0.947)^2} = 2.32$ inches	(12)
6	$Y = \sqrt{(1.592)^2 + (2.106 - 2)^2} = 1.60$ inch	(12)
7	$Y = \sqrt{(0.625)^2 + (2.890 - 2)^2} = 1.09$ inch	(12)
8	$Y = 1.09$ inch	
9	$Y = 1.60$ inch	
10	$Y = 2.32$ inches	
11	$Y = 3.22$ inches	
12	$Y = 4.03$ inches	
13	$Y = 4.72$ inches	

Tooth-space Number			
1	$\text{Tan } y = 0.000$;	$y = 0.000$ degrees	(13)
2	$\text{Tan } y = \frac{1.175}{2 + 2.578} = 0.257$;	$y = 14.416$ degrees	(13)
3	$\text{Tan } y = \frac{1.902}{2 + 1.549} = 0.536$;	$y = 28.199$ degrees	(13)
4	$\text{Tan } y = \frac{2.227}{2 + 0.318} = 0.962$;	$y = 43.883$ degrees	(13)
5	$\text{Tan } y = \frac{2.114}{2 - 0.947} = 2.007$;	$y = 63.516$ degrees	(13)
6	$\text{Tan } y = \frac{1.592}{2.106 - 2} = 15.03$;	$y = 86.200$ degrees	(13)
7	$\text{Tan } y = \frac{0.625}{2.890 - 2} = 0.703$;	$y = 35.1 + 90$ degrees $= 125.100$ degrees	(13)
8	$y = 125.100$ degrees		
9	$y = 86.200$ degrees		
10	$y = 63.516$ degrees		
11	$y = 43.883$ degrees		
12	$y = 28.199$ degrees		
13	$y = 14.416$ degrees		

Tooth-space Number		
1	$w = 0 + 90 = 90.000$ degrees	
2	$w = 14.416 + 50.623 = 65.039$ degrees	(14)
3	$w = 28.199 + 24.245 = 52.444$ degrees	(14)
4	$w = 43.883 + 4.849 = 48.732$ degrees	(14)
5	$w = 63.516 - 14.547 = 48.969$ degrees	(14)
6	$w = 86.200 - 33.943 = 52.257$ degrees	(14)
7	$w = 35.100 + 70.312 = 105.412$ degrees	(14)
8	$w = 105.412$ degrees	
9	$w = 52.257$ degrees	
10	$w = 48.969$ degrees	
11	$w = 48.732$ degrees	
12	$w = 52.444$ degrees	
13	$w = 65.039$ degrees	

Tooth-space Number		
1	$H = 5 \times 1 = 5.000$ inches	(15)
2	$H = 4.72 \times 0.90659 = 4.275$ inches	(15)
3	$H = 4.03 \times 0.79276 = 3.190$ inches	(15)
4	$H = 3.22 \times 0.75165 = 2.420$ inches	(15)
5	$H = 2.32 \times 0.75433 = 1.750$ inch	(15)
6	$H = 1.60 \times 0.79076 = 1.265$ inch	(15)
7	$H = 1.09 \times 0.96402 = 1.050$ inch	(15)
8	$H = 1.050$ inch	
9	$H = 1.265$ inch	
10	$H = 1.750$ inch	
11	$H = 2.420$ inches	
12	$H = 3.190$ inches	
13	$H = 4.275$ inches	

Tooth-space Number		
1	$D = 5 \times 0 = 0$	(16)
2	$D = 4.72 \times 0.42192 = 1.99$ inch	(16)
3	$D = 4.03 \times 0.60960 = 2.456$ inches	(16)
4	$D = 3.22 \times 0.65956 = 2.123$ inches	(16)
5	$D = 2.32 \times 0.65650 = 1.523$ inch	(16)
6	$D = 1.60 \times 0.61213 = 0.980$ inch	(16)
7	$D = 1.09 \times 0.26584 = 0.290$ inch	(16)
8	$D = 0.290$ inch	
9	$D = 0.980$ inch	
10	$D = 1.523$ inch	
11	$D = 2.123$ inches	
12	$D = 2.456$ inches	
13	$D = 1.990$ inch	

Example 2—Required, a pair of oval gears; major axis, 6 inches; focus distance, 4 inches; 14 teeth; bore at center of gear.

$$B = \sqrt{36 - 16} = 4.472 \text{ inches} \quad (1)$$

$$C = 1.6464 \times 6 + 1.4952 \times 4.472 = 16.5649 \text{ inches} \quad (6)$$

$$p'' = \frac{16.5649}{14} = 1.1832 \text{ inch} \quad (17)$$

$$r' = 6 - 0.5 \times 4.472 = 3.764 \text{ inches} \quad (4)$$

$$r'' = 0.75 \times 4.472 - 0.25 \times 6 = 1.854 \text{ inch} \quad (5)$$

$$a = \frac{57.295 \times 1.1832}{3.764} = 18.010 \text{ degrees} \quad (8)$$

$$a' = \frac{57.295 \times 1.1832}{1.854} = 36.565 \text{ degrees} \quad (9)$$

Tooth-space Number	x, Degrees	z, Degrees	Tooth-space Number	x, Degrees	z, Degrees
1	80.859	9.141	8	80.859	189.141
2	44.294	45.706	9	44.294	225.706
3	22.512	67.488	10	22.512	247.488
4	4.502	85.498	11	4.502	265.498
5	13.508	103.508	12	13.508	283.508
6	31.518	121.518	13	31.518	301.518
7	62.576	152.576	14	62.576	332.576

Tooth-space Number		
1	$h' = 1.854 \times 0.15888 = 0.294$ inch	(10)
2	$h' = 1.854 \times 0.71569 = 1.327$ inch	(10)
3	$h' = 3.764 \times 0.92377 - 1.528 = 1.952$ inch	(10a)
4	$h' = 3.764 \times 0.99692 - 1.528 = 2.232$ inches	(10a)
5	$h' = 3.764 \times 0.97234 - 1.528 = 2.132$ inches	(10a)
6	$h' = 3.764 \times 0.85249 - 1.528 = 1.682$ inch	(10a)
7	$h' = 1.854 \times 0.46046 = 0.853$ inch	(10)
8	$h' = 0.294$ inch	
9	$h' = 1.327$ inch	
10	$h' = 1.952$ inch	
11	$h' = 2.232$ inches	
12	$h' = 2.132$ inches	
13	$h' = 1.682$ inch	
14	$h' = 0.853$ inch	

Tooth-space Number		
1	$v' = 1.854 \times 0.98730 + 1.146 = 2.978$ inches	(11)
2	$v' = 1.854 \times 0.69842 + 1.146 = 2.442$ inches	(11)
3	$v' = 3.764 \times 0.38295 = 1.442$ inch	(11a)
4	$v' = 3.764 \times 0.07846 = 0.295$ inch	(11a)
5	$v' = 3.764 \times 0.23359 = 0.879$ inch	(11a)
6	$v' = 3.764 \times 0.52275 = 1.970$ inch	(11a)
7	$v' = 1.854 \times 0.88761 + 1.146 = 2.791$ inches	(11)
8	$v' = 2.978$ inches	
9	$v' = 2.442$ inches	
10	$v' = 1.442$ inch	
11	$v' = 0.295$ inch	
12	$v' = 0.879$ inch	
13	$v' = 1.970$ inch	
14	$v' = 2.791$ inches	

Tooth-space Number		
1	$Y'' = \sqrt{(0.294)^2 + (2.978)^2} = 2.99$ inches	(18)
2	$Y'' = \sqrt{(1.327)^2 + (2.442)^2} = 2.78$ inches	(18)
3	$Y'' = \sqrt{(1.952)^2 + (1.442)^2} = 2.43$ inches	(18)
4	$Y'' = \sqrt{(2.232)^2 + (0.295)^2} = 2.25$ inches	(18)
5	$Y'' = \sqrt{(2.132)^2 + (0.879)^2} = 2.31$ inches	(18)
6	$Y'' = \sqrt{(1.682)^2 + (1.970)^2} = 2.59$ inches	(18)
7	$Y'' = \sqrt{(0.853)^2 + (2.791)^2} = 2.92$ inches	(18)
8	$Y'' = 2.99$ inches	
9	$Y'' = 2.78$ inches	
10	$Y'' = 2.43$ inches	
11	$Y'' = 2.25$ inches	
12	$Y'' = 2.31$ inches	
13	$Y'' = 2.59$ inches	
14	$Y'' = 2.92$ inches	

Tooth-space Number		
1	$j = \frac{5.236 - (2.99 + 2.25)}{2} = 0.000$ inch	(19)
2	$j = \frac{5.236 - (2.78 + 2.43)}{2} = 0.013$ inch	(19)
3	$j = \frac{5.236 - (2.43 + 2.78)}{2} = 0.013$ inch	(19)
4	$j = \frac{5.236 - (2.25 + 2.99)}{2} = 0.000$ inch	(19)
5	$j = \frac{5.236 - (2.31 + 2.92)}{2} = 0.003$ inch	(19)
6	$j = \frac{5.236 - (2.59 + 2.59)}{2} = 0.028$ inch	(19)
7	$j = \frac{5.236 - (2.92 + 2.31)}{2} = 0.003$ inch	(19)
8	$j = 0.000$ inch	
9	$j = 0.013$ inch	
10	$j = 0.013$ inch	
11	$j = 0.000$ inch	
12	$j = 0.003$ inch	
13	$j = 0.028$ inch	
14	$j = 0.003$ inch	

Tooth-space Number		
1	$Y' = 2.99 + 0.000 = 2.990$ inches	(20)
2	$Y' = 2.78 + 0.013 = 2.793$ inches	(20)
3	$Y' = 2.43 + 0.013 = 2.443$ inches	(20)
4	$Y' = 2.25 + 0.000 = 2.250$ inches	(20)
5	$Y' = 2.31 + 0.003 = 2.313$ inches	(20)
6	$Y' = 2.59 + 0.028 = 2.618$ inches	(20)
7	$Y' = 2.92 + 0.003 = 2.923$ inches	(20)
8	$Y' = 2.990$ inches	
9	$Y' = 2.793$ inches	
10	$Y' = 2.443$ inches	
11	$Y' = 2.250$ inches	
12	$Y' = 2.313$ inches	
13	$Y' = 2.618$ inches	
14	$Y' = 2.923$ inches	

Tooth-space Number		
3	$\tan y' = \frac{1.952}{1.442} = 1.354; \quad y' = 53.550$ degrees	(21)
4	$\tan y' = \frac{2.232}{0.295} = 7.560; \quad y' = 82.466$ degrees	(21)
5	$\tan y' = \frac{2.132}{0.879} = 2.425; \quad y' = 67.591$ degrees	(21)
6	$\tan y' = \frac{1.682}{1.970} = 0.854; \quad y' = 40.500$ degrees	(21)
10	$y' = 53.550$ degrees	
11	$y' = 82.466$ degrees	
12	$y' = 67.591$ degrees	
13	$y' = 40.500$ degrees	

Tooth-space Number		
3	$w' = 53.550 + 22.512 = 76.062$ degrees	(22)
4	$w' = 82.466 + 4.502 = 86.968$ degrees	(22)
5	$w' = 67.591 + 13.508 = 81.099$ degrees	(22)
6	$w' = 40.500 + 31.518 = 72.018$ degrees	(22)
10	$w' = 76.062$ degrees	
11	$w' = 86.968$ degrees	
12	$w' = 81.099$ degrees	
13	$w' = 72.018$ degrees	

Tooth-space Number		
1	$H'' = 1.854 + 1.146 \times 0.98730 = 2.984$ inches	(23)
2	$H'' = 1.854 + 1.146 \times 0.69835 = 2.654$ inches	(23)
3	$H'' = 2.43 \times 0.97056 = 2.356$ inches	(23a)
4	$H'' = 2.25 \times 0.99860 = 2.248$ inches	(23a)
5	$H'' = 2.31 \times 0.98796 = 2.281$ inches	(23a)
6	$H'' = 2.59 \times 0.95115 = 2.460$ inches	(23a)
7	$H'' = 1.854 + 1.146 \times 0.88760 = 2.871$ inches	(23)
8	$H'' = 2.984$ inches	
9	$H'' = 2.654$ inches	
10	$H'' = 2.356$ inches	
11	$H'' = 2.248$ inches	
12	$H'' = 2.281$ inches	
13	$H'' = 2.460$ inches	
14	$H'' = 2.871$ inches	

Tooth-space Number		
1	$H' = 2.984$ inches	
2	$H' = \frac{2.654 \times 2.793}{2.78} = 2.667$ inches	(24)
3	$H' = \frac{2.356 \times 2.443}{2.43} = 2.370$ inches	(24)
4	$H' = 2.248$ inches	
5	$H' = \frac{2.281 \times 2.313}{2.31} = 2.283$ inches	(24)

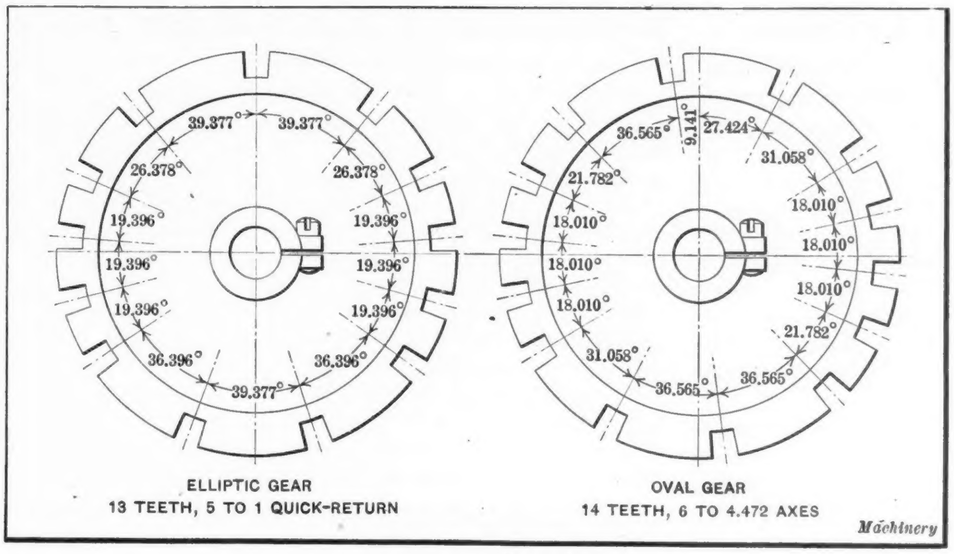


Fig. 9. Index Ratchet Wheels

6 $H' = \dfrac{2.460 \times 2.618}{2.59} = 2.486$ inches (24)

7 $H' = \dfrac{2.871 \times 2.923}{2.92} = 2.874$ inches (24)

8 $H' = 2.984$ inches
9 $H' = 2.667$ inches
10 $H' = 2.370$ inches
11 $H' = 2.248$ inches
12 $H' = 2.283$ inches
13 $H' = 2.486$ inches
14 $H' = 2.874$ inches

Tooth-space Number

1 $D' = 1.146 \times 0.15889 = 0.182$ inch (25)
2 $D' = 1.146 \times 0.71576 = 0.820$ inch (25)
3 $D' = 2.430 \times 0.24087 = 0.586$ inch (25a)
4 $D' = 2.250 \times 0.05292 = 0.119$ inch (25a)
5 $D' = 2.310 \times 0.15471 = 0.357$ inch (25a)
6 $D' = 2.590 \times 0.30874 = 0.800$ inch (25a)
7 $D' = 1.146 \times 0.46057 = 0.528$ inch (25)
8 $D' = 0.182$ inch
9 $D' = 0.820$ inch
10 $D' = 0.586$ inch
11 $D' = 0.119$ inch
12 $D' = 0.357$ inch
13 $D' = 0.800$ inch
14 $D' = 0.528$ inch

Machining the Gears

Of the numerous dimensions and calculations required for the correct design of the gears in the drafting-room, but three are of interest to the operator cutting the gears, after the proper cutter, or cutters, have been selected. These are the angle included between the tooth-space tangent and the major axis of the gear (or the angularity of the ratchet index), the horizontal and the vertical setting for the machining fixture. Any other information given to the machinist is likely to create confusion and lead to errors in his exacting task. A machining fixture secured to the table of the milling machine employed for cutting the teeth is the only special equipment required.

A simple and essentially practical fixture employed by the Bilgram Machine Works carries an arbor that may be set at any predetermined angle, upon which the blank to be cut is mounted on its bore. The angle at which the arbor is set is the angle included between the tooth-space tangent and the major axis, or the complement of such angle, and varies for the different tooth spaces. The distance between the parallel planes of the machining-fixture arbor and of the rotary cutter is adjusted for each individual tooth space so that the distance between the plane of the arbor and the parallel plane tangent to the pitch circumference of the rotary cutter in the cutting plane equals the vertical setting for the machining fixture previously determined. The coordinate setting of the fixture (or the horizontal setting for the machining fixture) is the distance between the plane of the rotary cutter and a parallel plane passing through the arbor of the fixture. This is similarly set, for each individual tooth space, to conform to the calculated value. These three adjustments must be made for each tooth space, and it is this multiplicity of adjustments that makes the cutting of elliptical gears intricate.

The teeth should be cut in consecutive order, so that the angular adjustment of the fixture arbor, though varying in amount from tooth space to tooth space, is always in the same direction. In the multiple production of elliptical gears, this is taken advantage of by mounting on the fixture arbor a ratchet wheel with notches that conform to the angular adjustments for the various tooth spaces. The most convenient ratchet wheel is circular and concentric with the fixture arbor so that the notches in its circumference are of varying pitch, their angular pitch conforming to the angle included between the center line of the rotary cutter and the major axis of the gear blank in successive positions. The 0—180 degree ratchet diameter should conform to the major axis of the gear. The ratchet angle for the normal for any particular notch is referred to in the notation and the examples as the "angularity of ratchet index." For any particular tooth space, this is the complement of the angle included between the tangent at such tooth space and the major axis. This arbitrary fixing of the ratchet angularity is dependent on commencing the cutting of the teeth at the small end of the gear; the first tooth space to be gashed is that on the major axis for elliptic gears, or that immediately to the left of the major axis for oval gears.

Fig. 9 illustrates the location of ratchet notches for the gears proportioned in the examples. The use of such ratchet indexes materially simplifies the question of the angular adjustment of the fixture and at the same time aids in securing uniformity in the product, the operator being relieved of much of the difficulty in making adjustments. Still further accuracy can be secured, when the gears are not of unusually wide face and can be securely bound together, by cutting several blanks at the same time. This is not always advisable, however. If the hubs of the gears are appreciably longer than the face of the gears, little time is saved; and should there be any variation in the metal of the blanks, there is increased danger of error through the work being forced out of alignment.

When the gears do not differ greatly in their major and minor axes—when their pitch outline does not vary much from a circle—the same cutter may be employed for all teeth; but when the ellipse is comparatively flat and there is considerable difference between the major and minor axes, a different cutter should be used for the major-radius segments from the one used for cutting the tooth spaces falling within the minor-radius segments. The cutter is selected, not for the number of teeth in the elliptical gear, but for the number of teeth of the same circular pitch that would be required for a circular gear having a diameter equal to twice the segment radius. For instance, the minor radius of the elliptic gear of Example 1 is 1.854 inch, the major radius is 3.764 inches, and the circular pitch is 1.2742 inch. The cutter for the spaces within the minor-radius segments should then be selected for a circular gear of the same pitch but with from nine to ten teeth ($2 \times 1.854 \times 3.1416/1.2742$); and the cutter for the spaces within the major-radius segments the same as for a circular gear with from eighteen to nineteen teeth ($2 \times 3.764 \times 3.1416/1.2742$).

* * *

Men who strive to build themselves up by tearing down the work of their fellows generally succeed in undermining their own foundations and falling into the common ruin. The secret of success is cooperative effort and giving to everyone credit for that which is his due.

MODERN TOOLMAKING METHODS

Progress is being made rapidly in manufacturing methods, and the mechanic who does not keep posted is likely to be left hopelessly behind the times. Many still have the conception that toolmaking is the making of odd tools from time to time as required in the shop; they do not fully realize that modern toolmaking is a highly developed business, carried along on manufacturing lines. A toolmaking concern that made tools as they are made in the tool-rooms of many manufacturing plants would soon close its doors. By pursuing manufacturing methods, however, a modern toolmaking concern is able to produce a great variety of small tools that are of superior quality at a comparatively low labor cost.

Many of the operations of toolmaking which have been regarded as within the capacity only of an experienced toolmaker are not necessarily those that cannot be performed satisfactorily by apprentices or other beginners. As a matter of fact, an apprentice may be taught quickly to do a variety of lapping operations, for instance. It does not require a great deal of skill and experience to be able to lap the holes in milling cutters after hardening so that a plug gage will fit freely but without shake.

It is by specializing and dividing tool work into its elementary parts and assigning them to mechanics of moderate skill, that the economies of modern manufacturing toolmaking practice are realized.

* * *

CORRECTION

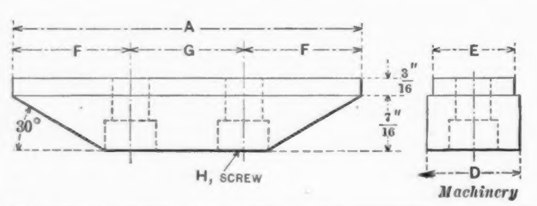
The elevating truck shown in Fig. D on the first page of "Factory Transportation" in the July number is a Stuebing truck made by the Stuebing Truck Co., Cincinnati, Ohio, and not a Barrett-Cravens truck, as stated in the caption.

MISCELLANEOUS STANDARDIZED PARTS FOR JIGS[1]

BY R. F. POHLE[2]

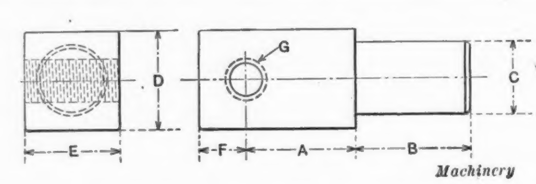
Tongues in the base of small fixtures are generally shaped from the casting itself. At times, however, it is desirable to be able to remove a tongue; for example, to reset it at right angles to its former position, thereby enabling an operator to mill, plane or slot a right angle without disturbing the work. In a fixture of this sort, grooves are milled in the base, into which the tongues are inserted. Tongues of this kind are also used to fasten into the base of long fixtures, say 12 inches or over. They will not collect dirt as readily as a planed tongue, and will thus eliminate the danger of improper seating and enter the platen slots more readily. It is not necessary to mill grooves for these tongues. They should, however, be doweled in place. Tongues are made of steel as shown in Table 1. The 30-degree angle at the lower corners is of no consequence. The tongues may be made square just as well.

TABLE 1. REMOVABLE TONGUES



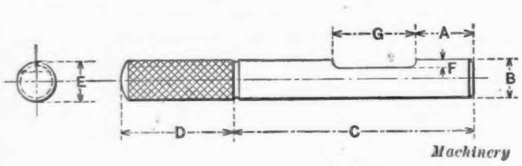
A	D	E	F	G	H
$2\frac{3}{4}$	$\frac{5}{8}$	$\frac{1}{2}$	$1\frac{3}{8}$	..	No. 14–24
$3\frac{3}{8}$	$\frac{5}{8}$	$\frac{1}{2}$	1	$1\frac{3}{8}$	No. 14–24
4	$\frac{5}{8}$	$\frac{1}{2}$	$1\frac{1}{8}$	$1\frac{3}{4}$	No. 14–24
$2\frac{3}{4}$	$\frac{3}{4}$	$\frac{9}{16}$	$1\frac{3}{8}$	..	$\frac{5}{16}$–18
$3\frac{3}{8}$	$\frac{3}{4}$	$\frac{9}{16}$	1	$1\frac{3}{8}$	$\frac{5}{16}$–18
4	$\frac{3}{4}$	$\frac{9}{16}$	$1\frac{1}{8}$	$1\frac{3}{4}$	$\frac{5}{16}$–18

TABLE 2. POPPETS



A	B	C	D	E	F	G Diameter and Number of Threads per Inch
$\frac{5}{16}$ to $\frac{13}{16}$	$\frac{5}{8}$	0.4385	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{4}$	No. 10–32
$\frac{5}{16}$ to $\frac{13}{16}$	$\frac{3}{4}$	0.501	$\frac{5}{8}$	$\frac{5}{8}$	$\frac{5}{16}$	No. 14–24
$\frac{5}{16}$ to $1\frac{1}{16}$	$\frac{13}{16}$	0.5635	$\frac{3}{4}$	$\frac{3}{4}$	$\frac{5}{16}$	$\frac{5}{16}$–18
$\frac{3}{8}$ to $1\frac{1}{8}$	$\frac{7}{8}$	0.6265	$\frac{7}{8}$	$\frac{7}{8}$	$\frac{3}{8}$	$\frac{3}{8}$–16
$\frac{3}{8}$ to $1\frac{1}{8}$	1	0.689	1	1	$\frac{3}{8}$	$\frac{7}{16}$–14
$\frac{1}{2}$ to $1\frac{1}{2}$	$1\frac{1}{8}$	0.7515	$1\frac{1}{8}$	$1\frac{1}{8}$	$\frac{1}{2}$	$\frac{1}{2}$–13

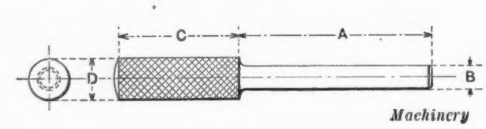
TABLE 3. PUSH-PINS



B	C	D	E	F	G
0.1865	$1\frac{1}{2}$ to $2\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{16}$	$\frac{1}{32}$	$\frac{7}{16}$
0.249	$1\frac{5}{8}$ to $2\frac{5}{8}$	$\frac{3}{4}$	$\frac{1}{4}$	$\frac{1}{32}$	$\frac{9}{16}$
0.3115	2 to $3\frac{1}{2}$	1	$\frac{5}{16}$	$\frac{3}{64}$	$\frac{11}{16}$
0.374	$2\frac{3}{8}$ to $3\frac{7}{8}$	1	$\frac{3}{8}$	$\frac{1}{16}$	$\frac{13}{16}$
0.4365	$2\frac{1}{2}$ to 4	$1\frac{1}{4}$	$\frac{7}{16}$	$\frac{5}{64}$	$\frac{15}{16}$
0.499	$2\frac{5}{8}$ to $4\frac{1}{8}$	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{5}{64}$	$1\frac{1}{16}$

Dimension A varies with the part to be held in the jig, and should be given on the tool drawing.

TABLE 4. KNURLED PINS



B	C	D	B	C	D
0.1875 to 0.2187	1	$\frac{5}{16}$	0.6250 to 0.6562	$1\frac{3}{4}$	$\frac{13}{16}$
0.2500 to 0.2812	$1\frac{1}{8}$	$\frac{3}{8}$	0.6875 to 0.7187	2	$\frac{7}{8}$
0.3125 to 0.3437	$1\frac{1}{4}$	$\frac{7}{16}$	0.7500 to 0.7812	$2\frac{1}{8}$	$\frac{15}{16}$
0.3750 to 0.4062	$1\frac{3}{8}$	$\frac{9}{16}$	0.8125 to 0.8437	$2\frac{1}{4}$	1
0.4375 to 0.4687	$1\frac{3}{8}$	$\frac{5}{8}$	0.8750 to 0.9062	$2\frac{1}{2}$	$1\frac{1}{16}$
0.5000 to 0.5312	$1\frac{1}{2}$	$\frac{11}{16}$	0.9375 to 0.9687	$2\frac{3}{4}$	$1\frac{1}{8}$
0.5625 to 0.5937	$1\frac{5}{8}$	$\frac{3}{4}$	1.000	3	$1\frac{1}{4}$

Dimension A varies with the part to be held in the jig, and should be given on the tool drawing.

In Table 5 are shown the proportions of what are generally called "seats." Seats are solid supporting points that come in direct contact with the work. The question of whether a seat should be of cast iron, finished, or of steel, hardened and ground, is decided by the conditions under which the designer is working. Where the number of pieces to be operated upon is not very great, or where the dimensions of the work show that it does not require to be very accurate, a cast-iron seat will probably give satisfaction. When tools are expected to produce duplicate parts within small limits of variation, hardened and ground steel seats, Table 5, may be relied upon.

A device known as a poppet is shown in Table 2. Poppets are used quite extensively; they serve as a lug to support an

[1] The tables of standards given in this article embody the practice of the General Electric Co., at Lynn, Mass. These standards were developed for the company by R. F. Pohle, when in charge of the tool designing department.
[2] Address: 265 Union St., Lynn, Mass.

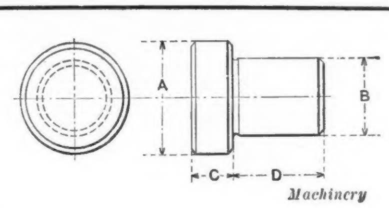
adjustment or holding screw when it is preferable not to have a lug on the casting itself. For instance, to facilitate the production of the jig or fixture, one might want to shape or plane a surface, an operation that would be difficult and expensive if a screw-supporting lug was in the way as part of the casting. Also, at times, the hole in the lug may not be accessible for drilling and tapping. Puppets are also used to support drill bushings.

Milled push-pins, as shown in Table 3, are used in small jigs and on very delicate work. They provide a removable supporting point for the work, replacing the screws commonly used, and thus eliminating danger of distortion of the work or jig by the operator. Push-pins can also be more quickly removed than a screw, an advantage which may be borne in mind. They are milled as shown, not only to keep the binding screw from burring the pin, but also to keep the pin from falling out.

The knurled pins in Table 4 are simply hardened and ground pins used either to insure the proper placing of the work (after which the pin is removed), or to pin together two loose parts of a jig. In the latter case, the pin, as well as the bushings that it enters, is tapered. It is used, for instance, in a swinging side leaf or a cover that may not otherwise be supported. Tables 6 and 7 simply give information as to the proportions of spring posts and knobs. The functions are quite apparent.

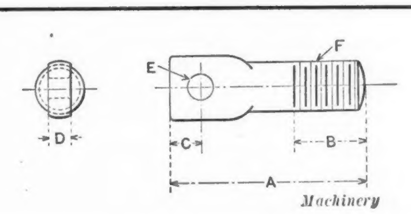
The primary object of this article is to call the attention of designing engineers to the fact that many parts of jigs and fixtures may be standardized, numbered, made by apprentices instead of skilled toolmakers, and kept in stock. It will also do away with the drawing of these parts over and over again by tool designers.

TABLE 5. HARDENED SEATS OR LOCATING PLUGS



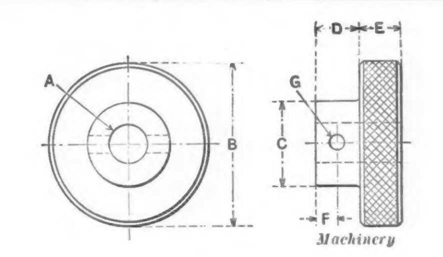
A	B	C	D	A	B	C	D
1/2	0.251	3/16	1/2	7/8	0.5635	1/4	5/8
9/16	0.3135	3/16	1/2	1	0.626	1/4	3/4
5/8	0.376	3/16	5/8	1 1/8	0.6885	1/4	3/4
11/16	0.4385	3/16	5/8	1 1/4	0.751	1/4	7/8
3/4	0.501	1/4	5/8	..	......	..	..

TABLE 6. SPRING POSTS



A	B	C	D	E	F Diameter and Number of Threads per Inch
1/2 to 1 1/8	3/16	3/32	1/16	1/16	No. 8–32
3/4 to 1 1/4	9/32	1/8	3/32	3/32	No. 10–32
1 to 1 3/4	3/8	3/16	1/8	1/8	No. 14–24
1 1/4 to 2 1/4	1/2	1/4	5/32	5/32	5/16–18
1 3/8 to 2 1/2	9/16	1/4	3/16	3/16	3/8–16
1 3/4 to 3	3/4	5/16	1/4	1/4	1/2–13
2 to 3 3/4	15/16	3/8	5/16	5/16	5/8–11
2 1/4 to 4 3/4	1 1/8	7/16	7/16	3/8	3/4–10

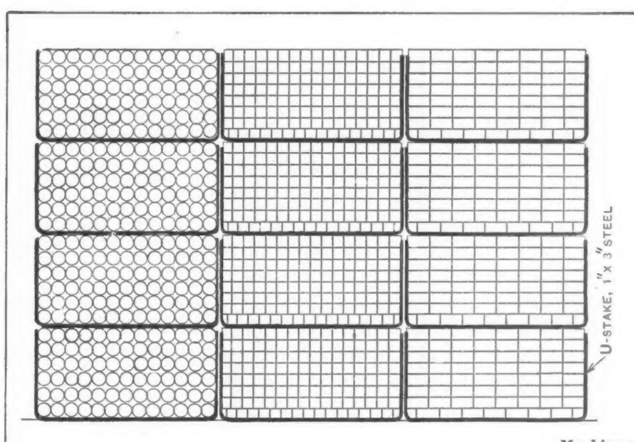
TABLE 7. KNOBS FOR JIGS AND FIXTURES



A	B	C	D	E	F	G
3/16	7/8	7/16	1/4	1/4	1/8	3/32
1/4 to 5/16	1 1/8	9/16	3/8	5/16	3/16	3/32
3/8 to 7/16	1 1/2	11/16	7/16	7/16	7/32	1/8
1/2 to 9/16	1 3/4	7/8	1/2	1/2	1/4	1/8
5/8 to 3/4	2 1/4	1 1/16	9/16	11/16	9/32	3/16

U-STAKES FOR PILING BAR STOCK

Racks for bars, strips, rods, pipe and other long metal stock are costly to construct and inconvenient to use. They are also inelastic and difficult to move when changes in the store-room are necessary. Racks may be avoided in many places by using piling stakes made of 1- by 3-inch steel bars bent to U shape, the U having a flat bottom and square corners, instead of a rounded contour. The stock is piled in these stakes, one being placed near each end of the pile. The width of the U-stake or frame may be from 30 to 36 inches and the height about 18 inches. When the pile has reached the top of the frames, another pair of frames is laid on the pile and the piling continued to any height required. Tiers may be ranged side by side, as indicated in the accompanying illustration, which shows piles of rounds, squares and flat stock, each held securely and neatly by the U-frames. When the stock is removed, there is no unsightly rack left to encumber the spot; the U-frames may be stored until required again, and new stock may be piled elsewhere if more convenient.



Illustrating Use of U-stakes for piling Bar Stock

* * *

The number of establishments making watches, watch parts, and watch movements in this country decreased from thirty-seven in 1869 to fifteen in 1914. The number of employes increased from 1800 to 12,390; the wages, from $1,304,000 to $7,524,000, and the value of the products from $2,819,000 to $14,275,000. In the same period the number of watch-case factories fell from forty-nine to thirty-one, while the value of the products increased from $2,333,300 to $7,821,000. In 1909, however, twenty-nine establishments produced cases to the value of $10,514,850. The imports of watches and watch parts have grown from $2,293,670, in 1911, to $3,362,720, in 1916, while the exports fell from $1,560,870 to $1,524,430. In 1915, only $914,770 worth of American watches and watch parts were sold abroad.

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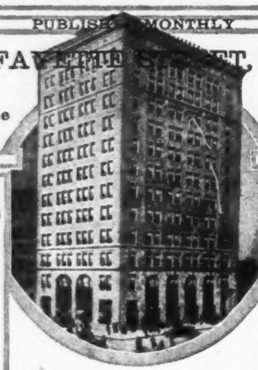

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FARM TRACTORS NOW AND AFTER THE WAR

The world is facing a shortage of food, now and after the war, and it is imperative for the farms to produce the maximum of food products at a minimum of cost. Farmers generally depend on animals for tractive power, but it is evident that in this mechanical age animal power must give way to tractors, which are propelled by engines fed by fuels cheaper than hay and grain—the food of the horse. The tractor is economical of farm labor because of the concentration of power under the control of one man. A tractor capable of exerting the draft power of many horses can be readily handled by one man, with comparatively little mechanical knowledge. The high-powered tractor capable of hauling ten plows at a uniform speed of 2 1/3 miles an hour, and operated by two men, will in a day of ten hours plow as much land as could be turned over by twenty single plows drawn by horses.

The adaptable farm tractor is that which can be used for all agricultural purposes, and which may also be used with a fair degree of efficiency for hauling produce to market. This combination of qualities is difficult to secure in one machine, but it is essential for the small farmers in the East to secure in one machine all the draft qualities of the horse in order to minimize investment.

A difficulty in the development of tractors and other machines driven by internal combustion motors, is the high price of gasoline and the apparent limitation of the world's supply of petroleum. The prospect of cheap alcohol seems remote. There is, it is true, the possibility of making gasoline from oil-bearing shales, but at present the cost of gasoline so produced is greater than that made in the ordinary way.

The future development of transportation methods on land and sea and in the air, and the improvement of agricultural conditions, hinges on the internal combustion motor. The improvement of motors and the development of cheap liquid fuels are fascinating subjects for invention and investigation.

* * *

REPLACING OLD MACHINE TOOLS WITH NEW

Now is the time for owners of manufacturing plants to consider ways and means for increasing the productive capacity of their plants without adding more buildings, which the present high cost of materials and labor will make an excessive burden in future. Never was it so necessary for owners and managers to give close attention to the interior arrangement of their plants, methods of routing work, and efficiency of machines. Many plants have machine shops in which there are machine tools that should have been scrapped years ago. It is not uncommon to find lathes thirty or forty years old that are still in use. These old-timers take up the same area of floor space as a modern machine tool with a productive capacity of fifty to one hundred per cent more. Obviously, the simplest way—and the cheapest in the end—to increase the productive capacity of an out-of-date machine shop is to discard the ancient tools and replace them with modern equipment. The labor cost will be decreased and the productive capacity of the plant, as a whole, materially increased.

There are few manufacturing plants in which the floor space is utilized nearly to its capacity. The use of efficient machine tools is a step in the right direction; efficient transportation means, and methods which prevent congestion on the floors and which keep the operators supplied with work is another. An important matter to be considered when purchasing new machine equipment is the floor space occupied. In some cases it will be found that the vertical type of machine tool is best suited to the product, and that the floor space required is less for a given production than it would be with machines of the horizontal type. If the horizontal type is required—lathes, for example—they should be no longer than necessary to accommodate the maximum length of piece to be produced. It is a mistake to purchase engine lathes with long beds when the maximum length of the pieces to be turned requires short bed lathes only.

* * *

IMPORTANCE OF STUDY OF SHOP MATHEMATICS

Mathematics may be said to be the foundation of all engineering. Without the aid of the processes of arithmetic, even the simplest mechanical work could hardly be done. In the design of machinery, and still more in the design of great engineering structures, calculations of a more or less advanced nature become absolutely necessary. Any mechanic with a limited education who contemplates the study of mathematics should make certain that he has fully mastered arithmetic. Just as mathematics is the basic science underlying engineering, so arithmetic is the basis of all mathematics. Without a thorough understanding of every process in arithmetic, other mathematical studies become difficult, if not impossible.

Many shop men refrain from using handbooks and other mechanical books containing formulas because they believe that an understanding of algebra is necessary in order to make use of such formulas as are given in handbooks. This idea is erroneous. With few exceptions, the formulas given in handbooks intended for machine shops can be used by anyone who thoroughly understands arithmetic. All that is necessary is to spend an hour or two reading an article explaining the purpose and use of formulas. In mathematics, a number of abbreviations, signs and symbols are also used; and it is of considerable value to the man who reads mechanical literature and occasionally uses formulas to memorize the commonly used signs and abbreviations. This will facilitate his progress and make it easier for him to grasp the meaning of a formula which otherwise would be obscure.

Closely allied to the use of formulas is the use of diagrams. A formula records a mathematical statement by means of symbols or letters, while a diagram records a similar statement graphically by means of lines. Many mechanics regard a diagram as something difficult to understand, but this is not the case, as anyone can easily find by studying a few of the diagrams presented in the mechanical journals.

The student who wishes to go further into the study of elementary mathematics should begin with a simple course in the solution of triangles and elementary geometry. If he wishes to proceed still further, he should take up logarithms and the solution of equations, and in connection with the latter subject he would acquire the rudiments of algebra.

THE LAW OF WARRANTIES

BY CHESLA C. SHERLOCK[1]

There are two kinds of warranties under the legal conception of the term, *viz.*, express and implied. An express warranty is a special warranty that expressly binds the maker thereof as to the fitness of a particular thing; while an implied warranty is a guaranty implied from the nature of the thing, the relation of the parties, or the agreement between them. Warranties cover a wide field and take in almost every phase of contractual relations. As applied to machinery, some special rules are in force that do not apply in other cases. Especially valuable and interesting is the rule of law as to which warranty governs a sale; that is, does the fact that a manufacturer expressly warrants a machine exclude or include implied warranties, or must the purchaser stand on the express warranty alone?

The Kentucky courts state the general rule to be that where there is an express warranty, there is no implied warranty. In the case under consideration, the contract provided that the machinery was sold subject "to the following express warranty and agreement, and none other." In Michigan, the rule is held to be that if there is "an express warranty as to the working qualities of machinery, there is no implication that the machinery is fit for the purposes for which it was purchased." In Indiana, the court said that although it is true that when a machine or other article is sold for a particular purpose there is an implied warranty that it is reasonably fit for the purpose for which it was made and sold, this rule does not apply where there is an express written warranty, since, in such cases, implied warranties are excluded. In Georgia, it is said that only in the absence of express warranties can resort be had to an implied warranty that a machine is reasonably fit for the use intended. In Illinois, the rule is: "Where a manufacturer furnishes a heating apparatus designed for heating a specific building, he impliedly warrants the sufficiency of the apparatus for the purpose intended. This implied warranty, however, cannot be availed of if the apparatus is sold upon an express warranty as to the temperature to which it will heat the rooms which it is designed to heat." In a Wisconsin case, it was stated that an express warranty of workmanship and material of cream separators excludes an implied warranty of fitness. In a Maine case, the court said: "The existence of an implied warranty that an automatic governor should be suitable for the purposes of the buyer's plant is negatived by the fact that the contract of purchase contained an express warranty as to quality as well as to speed, and the governors were such as the seller in the ordinary course of his business manufactured for the market, the general rule being that where an express warranty is made upon a sale, no other will be implied." The Missouri courts, however, have taken the other side of the question. They have held that there might be express warranties that do not exclude implied warranties, as there are any number of implied warranties that were never contemplated at the time the express warranties were made. This exception was not held, however, to apply to an implied warranty which in itself formed an integral element of the express warranty, into which it merged and by which its effect was circumscribed. The holding of the Missouri courts is on the theory that the express warranty is as to something wholly independent of the implied warranty. This distinction is as important as the distinction between express and implied warranties themselves.

It is a general rule, then, that an express warranty as to a particular phase of a thing will exclude all implied warranties as to the same thing. This rule is supported by the great weight of judicial authority and is practically universal. There are, however, some exceptions to the rule that are equally well supported by the weight of authority. In order for the general rule to apply, the character of the article warranted, as well as the express warranty thereto, must include all implied warranties on the same subject. The express warranty must also be of such a nature as to negative any contention that the manufacturer intended to assume any other obligation than the one assumed in his express warranty. If such a tendency does clearly exist, the courts are likely to declare that the implied warranties and the express warranties are separate in the particular case.

The law of warranties is so comprehensive a subject that it is possible to state here only the rules in force in cases involving machinery. The rules of law are the guide posts that point the way, and when a man is once familiar with these rules, he may proceed without stumbling through a maze of hazy legal decisions and counter decisions. The things to remember are that an express warranty excludes all implied warranties to the same subject, and that implied warranties will be considered either in the absence of express warranties or where it can be inferred from the agreement of the parties or the nature of the thing warranted that implied warranties were not intended to be included in the express warranty.

[1]Address: Box 253, Des Moines, Iowa.

* * *

RELATION OF RATE OF COOLING TO PHYSICAL PROPERTIES OF FORGINGS[1]

Two locomotive driving axles were used in some experiments recently conducted to study the rate of cooling in different medias and to try to connect the rate of cooling with the physical properties obtainable in quenched and tempered forgings. One of these axles was 11 inches in diameter and weighed 1830 pounds; the other was 12 inches in diameter, had a 3-inch hole bored longitudinally through it, and weighed 2000 pounds. In each case, the axles were heated uniformly as for quenching in the usual course of manufacture. The cutting compound used for quenching was composed of mineralized lard oil and soft soap mixed with equal parts of water. It was later diluted to one part of compound and two parts of water, and still later to three parts of water.

The tests show that in air the solid axles cool at a rate of 10 degrees F. per minute; in heavy oil, 26 degrees Baumé, at the rate of 25 degrees per minute; in the oil solution, at the rate of 35 degrees; in light oil, 29 degrees Baumé, at the rate of 45 degrees; and in water, at the rate of 80 degrees. The bored axle cooled in both the heavy oil and the cutting compound at the rate of 40 degree per minute. It was found that the dilution of the compound had little effect on its quenching properties.

In the case of the bored axle, it was found that when the 25 per cent solution of cutting compound was used, the axle cooled from 1450 to 700 degrees F. in 16.1 minutes. Its elastic limit was 40,500 pounds per square inch; its tensile strength was 78,000 pounds; its elongation in 2 inches, 29 per cent; and its reduction in area, 55 per cent. But when placed in the 33 per cent solution, the bored axle cooled in 13.6 minutes; its elastic limit was 43,000 pounds; its tensile strength, 81,500 pounds; its elongation in 2 inches, 30 per cent; and its reduction in area, 53.5 per cent. It was thought, however, that this more rapid cooling was due to some local condition that affected the convection of the bath.

When a jet of compressed air was introduced into the bath to give it a vigorous circulation, the rate of temperature fall was increased 80 per cent. Carbon steel that in the still bath had an elastic limit of 49,500 pounds per square inch, a tensile strength of 95,000 pounds, an elongation in 2 inches of 20.5 per cent, and a reduction in area of 43.5 per cent, when quenched in the agitated bath had an elastic limit of 68,800 pounds, a tensile strength of 105,300 pounds, an elongation in 2 inches of 21 per cent, and a reduction in area of 42 per cent. Chrome-vanadium steel axles quenched in a still bath had an elastic limit of 80,500 pounds per square inch, a tensile strength of 123,500 pounds, an elongation of 20.5 per cent, and a reduction of area of 57.5 per cent. When quenched in an agitated bath, this steel had an elastic limit of 9o,000 pounds, a tensile strength of 124,000 pounds, an elongation of 16.5 per cent, and a reduction of area of 61.5 per cent.

* * *

Last year, 4676 automobiles were imported into Argentina, against 1847 in 1915. Most of these were small cars designed particularly for country use, as such cars are becoming popular among the farmers.

[1]Abstract of a paper by Lawrence H. Fry, read before the Iron and Steel Institute of Great Britain, May, 1917.

SNAPSHOTS ON THE ROAD

THE RIGHT SIDE OF A PIECE OF STEEL—ASSEMBLING A CLOCK MOVEMENT IN TWO MINUTES—BROACHING CAST IRON—DUPLICATE FORM TURNING—WHAT'S THE MATTER WITH THE MUNITIONS MAKERS?—HOW A DOUBLE-ANGLE MILLING JOB WAS HANDLED—LAPPING GAGES FOR PROFIT—USING UP HIGH-SPEED STEEL DRILLS

BY THE FIELD EDITORS

"—the bottom side hardened to perfection while the face was as soft as cheese"

THERE are still a few shops in the country that make use of what is known as "composite steel" for blanking die work. Composite steel is formed by rolling together a piece of iron and a piece of tool steel. The result is a plate, one side of which is steel and the other iron. It has been claimed that a die made from this steel could be machined with less trouble than a solid steel die, and with practically no danger from cracking in hardening. While looking around through one of these shops where composite steel had been a great favorite, we heard the following incident, which has a mechanical moral:

"It was in the days when I was toolmaking," said the manager of the jewelry making plant—"and I was considered a pretty good die-sinker, too—that one day we had a little emblem die to make from which but a few strikings were required, so I picked up a scrap of composite steel and commenced to sink the design. After working on this for five or six hours, I tumbled to the fact that it worked too soft, and the horrible suspicion came to me that I had the piece of composite steel wrong side up and was cutting the design in the iron face of the plate instead of the steel. The longer I worked at it, the surer I was that I was wrong, and as soon as I tried to harden the die I was positive, for the bottom side hardened to perfection while the face was as soft as cheese.

"Someone has made the remark that during the few seconds' interval between the time when think you have made a mistake and when you find out whether you have or not, you are getting real experience. Well, I went through those seconds and got the experience, but the next thing was how to get out of the dilemma. It was a rush job and we had no time nor facility for pack-hardening, so I casehardened with cyanide, soaking in the cyanide to get all the depth of case possible. Even then I doubt if the die would have passed, even for the small number of parts required, if I hadn't gotten on the right side of Old Tom, the drop man, and told him that I suspected that die was made of a poor piece of steel and to nurse it along as carefully as possible. Old Tom got out the order, but he did some cussing and declared at the end that that sure was some bum steel in that die."

Assembling a Clock Movement

In going about the field, many examples of manual dexterity are seen, especially in factories where girls are employed. Recently, while in a Connecticut clock shop, the superintendent called attention to the assembling of a movement for a cheap alarm clock. The girls on the job had large compartment trays, each space of which contained a quantity of wheels or shafts of one kind. The assembler dropped one of the frame plates of the movement onto a simple little fixture before her and with her right hand rapidly reached for the various wheels and shafts, located them in the frame, and held them in place with her left hand.

"We used three broaches for the job; the first left the outline of the slot in a succession of notches"

How that right arm did fly! After she had all the wheels in their correct places in the frame plate, still loosely held in her left hand, she fitted on the top plate. With a quick little shake, at the same time rapidly adjusting the various parts with her left hand, she had the shafts and other parts in the proper pivot holes in the two plates. The top plate was held in place by twirling two little nuts on diagonally opposite parts and the job was done—total elapsed time, less than two minutes!

"With a quick little shake . . . she had the shafts and other parts in the proper pivot holes"

Broaching Cast Iron

"We worried a lot over this machining problem," said the chief engineer of the plant that we were visiting, "and you will be interested to know how we finally solved the problem. Now here's what we had to do," said he, as he reached for a piece of paper and rapidly sketched away. "You see, there's an irregular cored slot that runs out of this cast-iron plate, which, by the way, is one inch thick. Of course, you will see we couldn't mill these quickly without a profiler, and our production wasn't great enough to install such a machine. We got through the job very nicely, however, by broaching."

"But we have always considered the broaching of cast iron a rather difficult job on account of the tendency to break out at the end of the broaching cut."

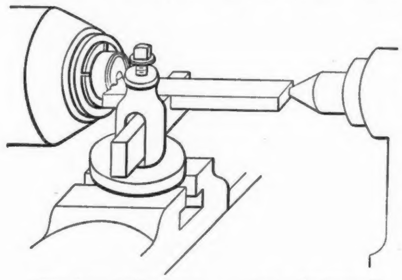
"You're dead right there, and that made the job all the more interesting. See, here's how we overcame that breaking-out tendency. We used three broaches for the job; the first left the outline of the slot in a succession of notches, just as I'm drawing it. We followed this broach by a second one that took 'bites' out of the center of each of the notches. Then we finished up with a plain broach that took the ridges from the slot and left it as finely finished as you could desire and without the sign of a break at the end of the cut."

"That's sure a new wrinkle in broaching," said we, "and a mighty good one to remember."

Duplicate Form Turning

It is surprising how often you see a new kink in some little shop where you wouldn't expect to find anything more modern than a grindstone. You may have to unearth it from beneath a pile of obsolete practice, but when you get it out it looks pretty good. Such was the case in a little job button manufacturing concern in good old New England. It seems that this company often has a set of fifteen or twenty sample buttons to turn, or molds for making buttons, or possibly punches for press work. It is necessary to face the molds or punches with the concentrically turned form and the exact form of the rings does not matter as long as they are all alike.

The boss lathe hand is an ingenious Yankee, and he has a "universal" form-turning tool that you can understand better from the sketch than from a page full of words. This form tool is made from a rectangular piece of steel about three-eighths by one inch and the shank is fitted in a slot in a block held in the toolpost, and is operated from the tail-center. The operation is simplicity itself. The lathe hand merely adjusts the tool by means of the cross-slide and feeds it in with the tailstock. The slot in the block of the cross-slide insures each punch, each button mold part or punch being turned exactly the same. A great number of variations are possible by merely moving the cross-slide and hence the tool, and as long as the cross-slide is moved the same amount for each operation, the pieces are exact duplicates.



"The boss lathe hand . . . has a 'universal' form-turning tool"

It is a simple little kink and there ought to be many ways of applying it to general machine shop practice.

What's the Matter with the Munitions Makers?

We recently ran into a fine example of "frenzied buying" as done by one of the mushroom munition plants that have been so much in the limelight of late. It was told to us by an efficiency expert who had been called in to straighten out things after they had run so wild that no one knew where they were "at." One of the grinding-room foremen wanted a diamond for truing grinding wheels, and put in his requisition. He stated the approximate size that was required, and one of the buyers of the purchasing department promptly got busy and bought a pure, flawless, blue-white diamond, for which he paid the meager sum of $900. The interesting part of it is that they did not send the diamond back, but actually put it into service truing grinding wheels.

Another glaring example of inefficiency was in an order of dies that was placed soon after the plant was started. An order for twenty-four duplicate dies for punching one particular part was given to a diemaking concern. The order was delivered promptly by putting every man in the shop on the job. After several months, it occurred to the diemaking concern that there ought to be another order coming for dies if such quantities had been needed before, so the manager went around to interview the purchasing department of the munitions plant. Being somewhat friendly with one of the purchasing agents, he naturally put his proposition to his friend, who simply smiled and said, "Come with me for a minute." Out through the shop they walked and into one of the storehouses, and there, stored in an orderly fashion, were twenty-three sets of the dies. These dies were all slushed with grease just as they had been received and had never seen service.

"Well," said the die manufacturer, "what's the answer?"

"Simplicity itself," was the reply. "The engineering department ordered us to secure twenty-four sets of dies for this part before they were sure that the part was exactly what they wanted. After a few thousand impressions had been made from the first set, they discovered that they were on the wrong track, and consequently these twenty-three sets of dies are scrapped."

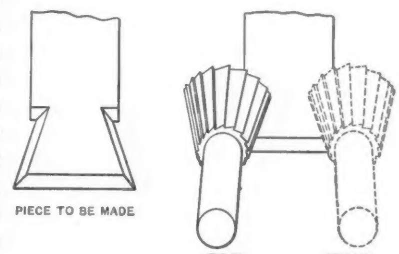
How a Double-angle Milling Job was Handled

"Say," said the master mechanic, "we've just finished solving a pretty little milling job for producing a piece like this one I'm drawing, and I'll be interested to hear how you would have done it." The piece referred to was made of carbon steel and its end was dovetailed as shown. The complicated part of it was that the edges were not cut straight across, but on an angle of about 5 degrees, similar to a milling cutter tooth.

"And before you decide just how you would have handled this," said the superintendent, "remember that it's a manufacturing job on which we must have thousands of parts, and we can't stand for a special machine, because on munition work the styles are apt to change at ten minutes' notice."

We racked our memory for a similar job without success, and, finding none, had to appeal to the superintendent for the explanation.

"Well, the solution was so simple it was funny we didn't strike it long ago. We simply had a special end-mill made to agree with the dovetail taper, and holding the pieces one at a time in a special fixture on the hand milling machine, ran the work straight up onto the cutter, but not across it; the resulting surface was angular and slightly concave. Next we dropped the work, ran it around the cutter to the opposite edge and milled it in the same way, and we got as pretty a result as you could want.



"the solution was so simple it was funny we didn't strike it long ago"

"Of course," concluded the superintendent, "you'll say we didn't get a perfectly true angle by using the surface left by a cylindrical end-mill, and you're right, but the resulting slightly concave surface was highly satisfactory and made an even better fit in the slot than it would have if it had been straight."

Lapping Gages for Profit

"Before you go," said the tool-room foreman, "sit down here and let me tell you about a big job of gage lapping that we had in the shop some time ago and how we handled it. You see, we only had one good man who could lap work and get away with it, and it was soon evident that we wouldn't be able to get the job out on time if we depended only on his ten-hour-a-day services, so we asked him about taking some of the work home and doing it evenings; we thought it would be pleasanter than staying at the factory, as none of the other men were working overtime.

"Schwarz was a big, good-natured German of a philosophical turn of mind. Every morning he brought in a good number of lapped gages and soon the contract was over. His overtime work did not seem to tire him, so one day, when the work was nearly done, I asked him how it was he could stand so much extra work without tiring, and he replied:

"'Oh, dot vas easy. I yust pull up mein chair side mit de lapping block, light mein pipe, and make one hand go, so and so, while I read mein paper mit comfort, and pretty soon I look at the gage—maybe he be all right, maybe not; that makes no never minds, I rub him some more and bimeby he sure be done.'"

"And so it was. Schwarz's gage lapping was no tax on his strength, because he reduced his right hand to an automaton that worked while he read—which wasn't so bad."

"I yust pull up mein chair side mit de lapping block, light mein pipe, and make one hand go so and so, while I read mein paper mit comfort"

Using up High-speed Steel Drills

High-speed steel turning tools cost money these days, so anything new in the turning tool line attracts our attention. Not long ago we were walking by the tool stock-room of a shop in Syracuse, where we saw an unusual lathe tool. It seems that the company uses a lot of two-inch high-speed steel drills, and when they are worn down too short for the work, they are forged down and the twist is taken out, turning them into lathe tools. The men say they are the finest kind of turning tools, and they make a saving in the steel bill besides.

GRIDLEY TURRET LATHE EQUIPMENT[1]

CHUCKS, FORMING AND CUTTING-OFF TOOLS, DRILL-HOLDERS, KNURLING TOOL-HOLDERS, TURNERS, BACK-RESTS, ETC.

BY DOUGLAS T. HAMILTON[2]

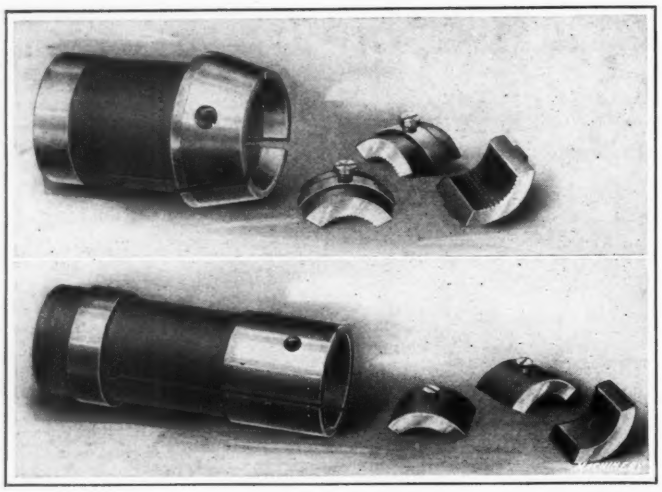


Fig. 1. Master Spring Chuck and Feed Chuck with Gripping Jaws removed

THE tool equipment and attachments used on the Gridley single-spindle automatic turret lathes do not differ essentially from those used on the multiple-spindle type of machine. The tool-holders, however, are held on flat slides instead of on the corner of the turret, as in the multiple-spindle machines. The standard tool equipment consists of spring chucks, feed chucks, vertical and flat forming tools, blade-type cutting-off tools, drill-holders, facing tools, knurling tools, internal necking tools, turners, high-speed drilling attachments, automatic die attachments, releasing tap-holder attachment, and taper turning attachment. Other special tools, of course, can be designed when the character or shape of the work necessitates the performance of operations that cannot be handled with the standard equipment.

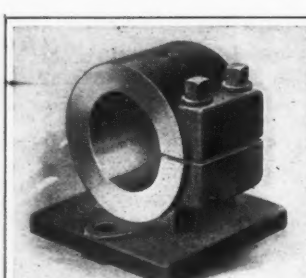


Fig. 2. Standard Type of Tool-holder used on Turret Slide of Gridley Automatic Turret Lathe

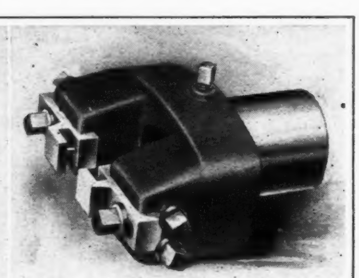


Fig. 3. Standard Type of Knurling Tool-holder for Use on Turret Slide of Gridley Automatic Turret Lathe

Spring Chuck and Feed Chuck

The spring chuck and the feed chuck used in the single-spindle turret lathe are exactly the same as those used on the multiple-spindle machines; in fact, the chucks used on the 1¾- and 2¼-inch sizes are interchangeable. On the single-spindle turret lathes, of course, the smallest capacity of the machine is such that the master spring chuck and feed chuck are used exclusively, and these are fitted with bushings to suit the size and shape of the work being handled. The illustration accompanying Table 1 shows the design of the spring chuck, and the principal dimensions are given for the 2¼-, 3¼- and 4¼-inch machines. It will be noticed in this connection that the taper on the front end of the chuck is only 14½ degrees on the 2¼-inch size, whereas it is 15 degrees on the 3¼- and 4¼-inch sizes. Another difference that should be noticed is that the chucks used on the 3¼- and 4¼-inch sizes have four slots and four bushing sections, instead of three, as on the 2¼-inch size.

The illustration accompanying Table 2 shows the type of master feed chuck used and the table gives the principal dimensions. These chucks are also interchangeable with those on the same size of multiple-spindle machines, and the number of slots and bushing sections vary on the 3¼- and 4¼-inch sizes, as mentioned in connection with the spring chuck. On the 3¼- and 4¼-inch feed chucks, the diameter is not reduced at *L*, but the diameter *A* extends from the front back to the shoulder at *J*; otherwise the feed chucks used on the various sizes of machines are identical in shape. Fig. 1 shows a master spring chuck and a feed chuck with the bushings removed

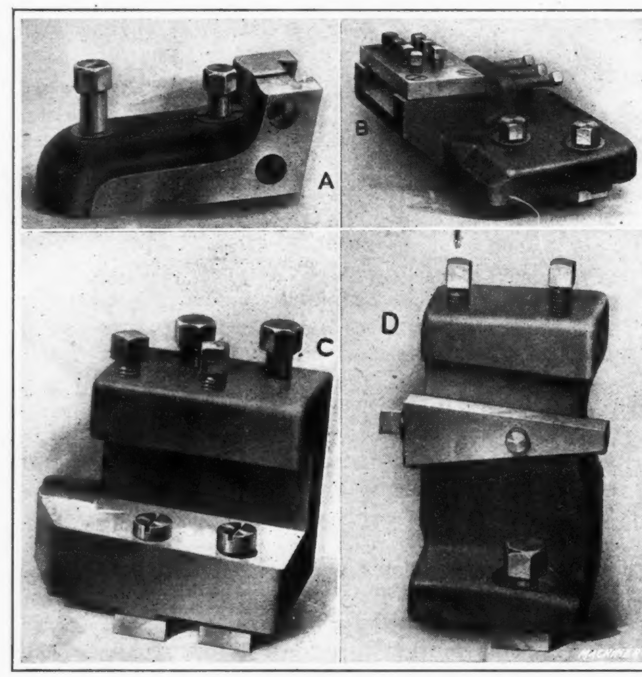


Fig. 4. Forming and Cutting-off Tool-holders used on Gridley Single-spindle Automatic Turret Lathe

and illustrates clearly the shape of the bushings and the method of holding them.

Forming and Cutting-off Tools

The forming and cutting-off tools used on the single-spindle turret lathe do not differ materially from those used on the multiple-spindle machine. When an irregular form is to be produced the vertical type of forming tool gives the best results. When several diameters are to be formed and only a small number of parts are to be turned out, individual forming tools consisting simply of blades for covering each diameter are satisfactory. It should be stated, however, that when a large number of parts are to be produced a tool covering the entire form, if possible, is better than a tool made up in separate parts, as it is easier to set up the tool again after

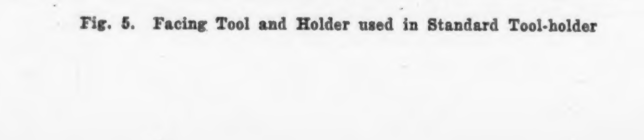
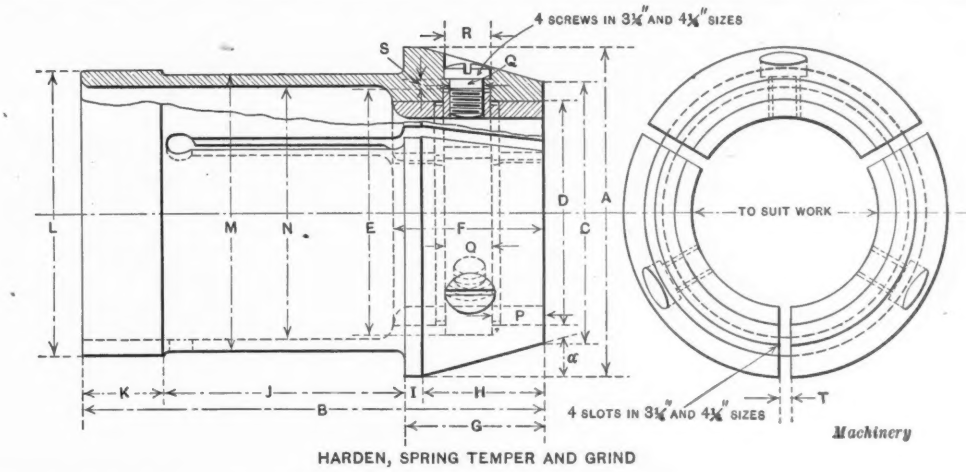


Fig. 5. Facing Tool and Holder used in Standard Tool-holder

[1] For other articles on Gridley automatic screw machine practice, see "Gridley Multiple-spindle Automatic Screw Machines" in the June and July, 1917, numbers of MACHINERY, and the articles referred to in connection with the first installment.

[2] Address: Fellows Gear Shaper Co., Springfield, Vt.

TABLE 1. PRINCIPAL DIMENSIONS OF MASTER SPRING CHUCKS FOR GRIDLEY SINGLE-SPINDLE TURRET LATHES



HARDEN, SPRING TEMPER AND GRIND

Size of Machine	Dimensions, Inches																		
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	α, Degrees
$2\frac{1}{4}$	$3\frac{1}{2}$	$5\frac{1}{32}$	2.7966	$2\frac{3}{8}$	$2\frac{5}{8}$	$1\frac{5}{8}$	$1\frac{1}{2}$	$1\frac{5}{16}$	$\frac{3}{16}$	$2\frac{31}{32}$	$\frac{7}{8}$	3	$2\frac{15}{16}$	$2\frac{11}{16}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{32}$	$14\frac{1}{2}$
$3\frac{1}{4}$	$4\frac{11}{16}$	$5\frac{5}{8}$	3.9173	$3\frac{3}{8}$	$3\frac{9}{16}$	$1\frac{3}{4}$	$1\frac{5}{8}$	$1\frac{7}{16}$	$\frac{3}{16}$	3	1	$4\frac{5}{16}$	$4\frac{1}{8}$	$3\frac{3}{4}$	$\frac{1}{2}$	$\frac{5}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{16}$	15
$4\frac{1}{4}$	$5\frac{3}{4}$	7	4.8625	$4\frac{3}{8}$	$4\frac{9}{16}$	$1\frac{7}{8}$	$1\frac{3}{4}$	$1\frac{21}{32}$	$\frac{3}{32}$	$4\frac{1}{4}$	1	5.495	$5\frac{3}{8}$	$4\frac{7}{8}$	$\frac{1}{2}$	$\frac{11}{16}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{8}$	15

it has been sharpened. The cutting-off tools are generally of the blade type, except when it is necessary to make them perform some part of the forming operation.

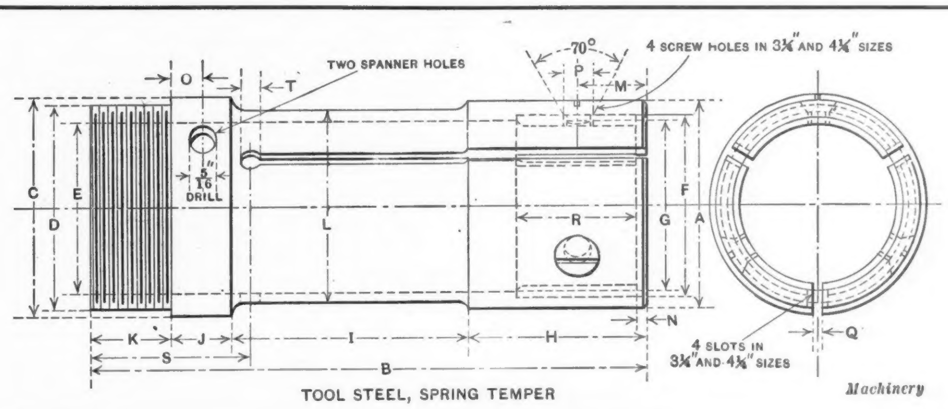
Forming and Cutting-off Tool-holders

Fig. 4 shows types of forming and cutting-off tool-holders used on the single-spindle turret lathe. That shown at *A* is known as the vertical tool-holder and is the type generally used, because the cutting tool can be held much more rigidly than in the other designs. The tool also can be ground on its top face without changing the form on the work, and it has a longer life than the straight forming tool.

When the piece to be formed has several plain diameters, the flat forming tool-holder shown at *B* is sometimes found convenient. This tool-holder, of course, is only used when there are a small number of pieces to be made and when the expense of making a vertical forming tool would not be warranted. It is also used when several narrow forming tools are required, spacing pieces being put in between the tools and the entire number clamped in the holder. Three adjusting screws are provided, as shown, so that three separate tools can be independently adjusted; they are then clamped by the other set of screws.

The plain forming tool-holder shown at *C* is sometimes used for forming back of the head of a screw or for similar work, so that the cutting-off tool is relieved of considerable work. It is also used for beveling the end of the bars before it is fed out, and thus assisting the turner in starting, especially in

TABLE 2. PRINCIPAL DIMENSIONS OF MASTER FEED CHUCKS FOR GRIDLEY SINGLE-SPINDLE TURRET LATHE



TOOL STEEL, SPRING TEMPER

Size of Machine	Dimensions, Inches																		
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
$2\frac{1}{4}$	2.560	7	2.620	$2\frac{1}{2}\times24$ P. L. H.	$2\frac{1}{8}$	$2\frac{1}{4}$	$2\frac{1}{8}$	$2\frac{1}{4}$	3	$\frac{3}{4}$	1	$2\frac{3}{8}$	$\frac{7}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{1}{8}$	$1\frac{1}{2}$	2	$\frac{1}{4}$
$3\frac{1}{4}$	$3\frac{5}{8}$	$7\frac{1}{8}$	3.745	3.580 ×18.P. R. H.	$3\frac{5}{16}$	$3\frac{1}{4}$	$3\frac{1}{8}$	—	—	$\frac{3}{4}$	1	$3\frac{5}{8}$	$\frac{7}{8}$	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{5}{16}$	$\frac{1}{8}$	$1\frac{1}{2}$	2	$\frac{1}{4}$
$4\frac{1}{4}$	$4\frac{11}{16}$	$7\frac{1}{4}$	4.808	$4\frac{5}{8}\times18$ P. L. H.	$4\frac{3}{8}$	$4\frac{1}{4}$	$4\frac{1}{32}$	—	—	$\frac{7}{8}$	1	$4\frac{11}{16}$	$\frac{7}{8}$	$\frac{1}{8}$	$\frac{7}{16}$	$\frac{5}{16}$	$\frac{1}{8}$	$1\frac{1}{2}$	2	$\frac{1}{4}$

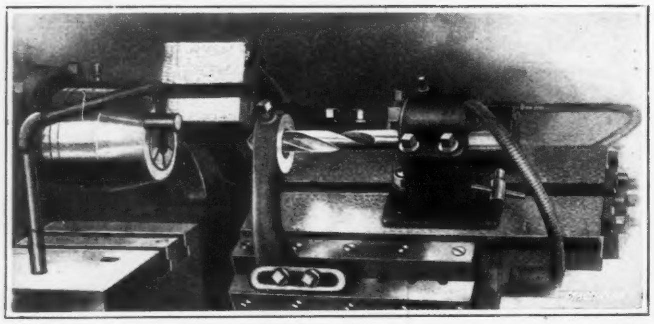


Fig. 6. Standard Type of Drill-holder and Drill-support in Operation

giving the back-rests a chance to support the work when the turning cut starts.

D shows the standard type of cutting-off tool-holder used on the single-spindle machine. This holder, as shown, is fitted with an adjustable taper wedge so that the cutting-off blade can be easily adjusted to correspond with the center of the work. Ordinary forged tools can be held in this holder or almost any type of blade inserted. When a large number of pieces are to be made it is advisable to use a blade-type of cutting-off tool and a holder. This simplifies the sharpening of the tool, as a blade-type tool has clearance all the way back

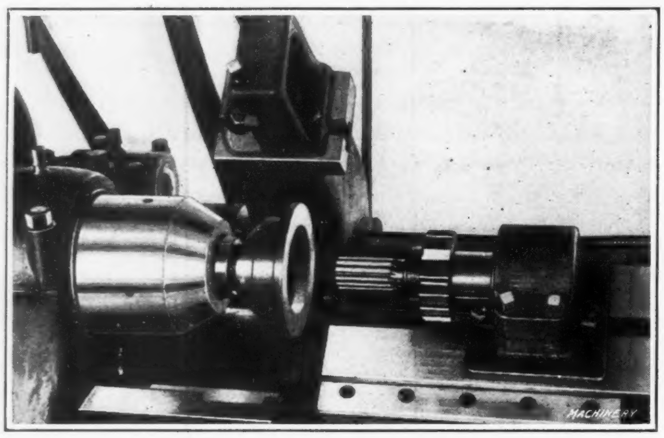


Fig. 7. Standard Tool-holder carrying Reamer

and to sharpen it is simply ground on the front end to the required cutting angle.

Tool-holders

The standard type of tool-holder used on the Gridley single-spindle turret lathe is shown in Fig. 2. This tool-holder is bolted directly to the turret slide and is bored out when in place on the machine so that the hole is in direct alignment with the spindle. It is held in place by means of two T-bolts, which, if desired, can be threaded; an adjusting screw laid in the T-slot in the slide can then be used for accurately adjusting the tool-holder longitudinally along the slide. This screw, of course, is provided with a collet head, and a plate attached to the rear end of the slide acts as a stop for adjusting purposes. The various tool-holders are numbered to correspond with the number of the tool-slide to which they are fastened when finished, and should be used only on the tool-slide having that number. They can be used, of course, by the substitution of bushings and other independent holders for carrying facing tools, drills, pointing tools, etc. Fig. 5 shows a tool-holder arranged to hold a pointing tool. A separate bushing is provided for guiding the bar, and the pointing tool is held in another sleeve, the latter being retained in the holder.

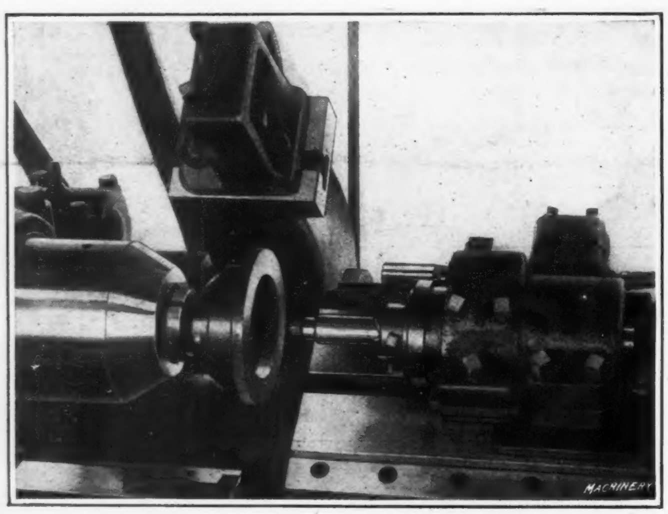


Fig. 8. Standard Holder carrying Reamer and Counterboring Tool

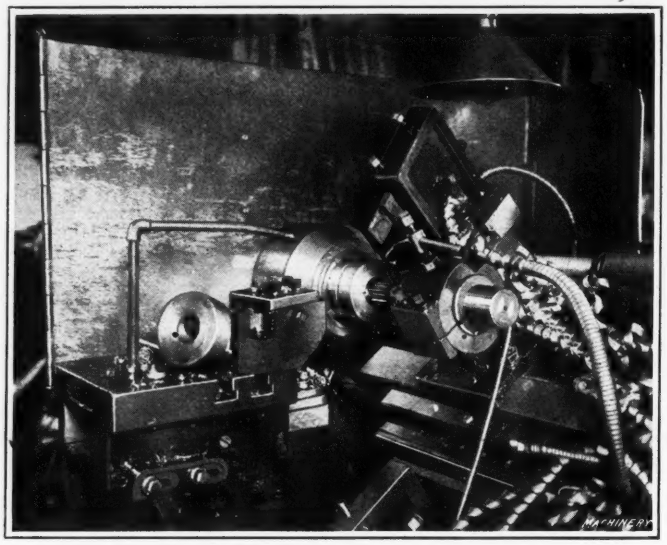


Fig. 9. Standard Type of Reamer Holder at Work

Drill-holder and Support

In Fig. 6 is shown the standard tool-holder carrying a twist drill, which is held in a bushing fitting in the holder, so constructed that an oil-tube can be inserted for supplying a coolant to the drill. The drill should be of the oil-tube type, so that the oil can flow directly to the cutting point. In addition, the drill is supported close to the cutting point, by means of an arm which is fastened to the turret in such a position

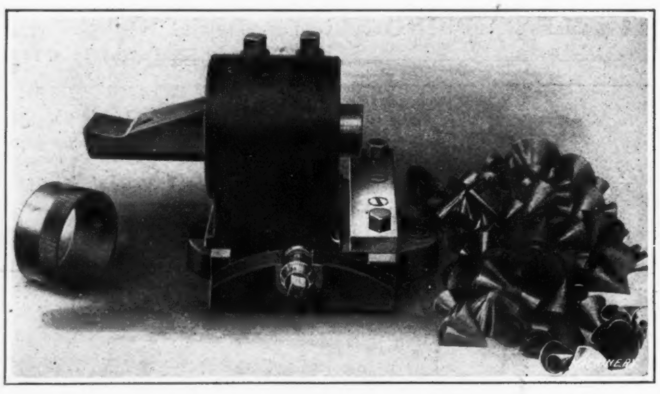


Fig. 10. Set-over Tool and Holder and Chip produced by it

that it is close to the end of the piece being drilled. The arm holds a bushing which fits the drill and accurately guides it in line with the work. This insures the tool starting concentrically and obviates the necessity of using a starting drill.

Fig. 9 shows a standard tool-holder carrying a reamer. The reamer is mounted so that it can float and is carried in a separate bushing in the tool-holder. In this illustration the screw for adjusting the main tool-holder longitudinally can be plainly seen, as well as the forged type of cutting-off tool, and the tool-holder for carrying separate forming tool blades. In Fig. 8 is illustrated another application of a reamer-holder, which is used in conjunction with a facing and counterboring tool. The reamer is of the shell type. The job shown is a

hub which is chucked by hand. Fig. 7 shows still another application of the standard holder. In this case it is used for carrying a boring tool, operating on a chucking job.

Knurling Tool-holder

The standard type of knurling tool-holder used on the Gridley automatic turret lathe is shown in Fig. 3. This has a

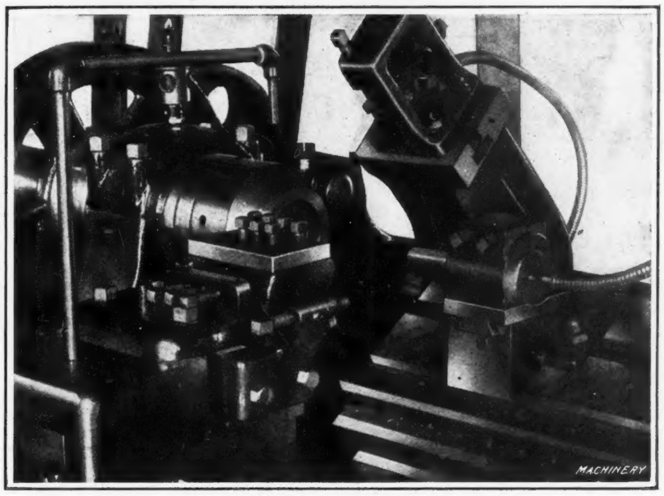


Fig. 11. Internal Necking or Recessing Tool

shank which can be held in the standard tool-holder and carries two adjustable slides that hold the spiral knurls. Two straight knurls can be used when it is necessary to produce a straight knurled effect on the work.

Set-over Tool and Holder

An interesting type of tool which takes the place of a drill for producing shallow holes (not more than one and one-half times its diameter) is shown in Figs. 10 and 12. This is known as a "set-over tool-holder," and it can be used with success on the Gridley turret because of the rigid construction of the latter. The cutting tool works the same as a forming tool, but instead of cutting on the outside surface of the bar, as the forming tool does, it cuts into the end of the bar, and as the holder which supports the tool has a set-over adjustment, the same cutting tool can be used for making holes of various diameters. It is not necessary to use a starting drill

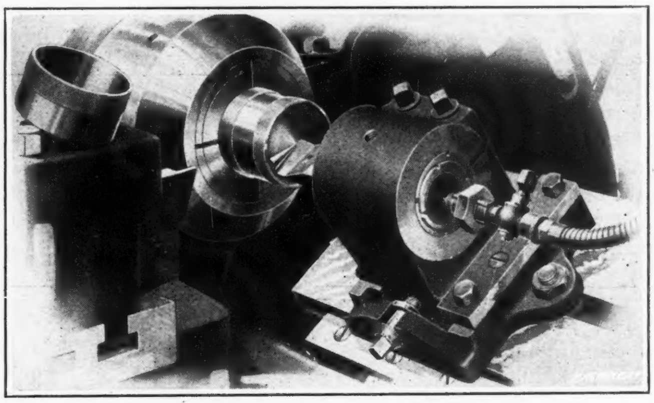


Fig. 12. Set-over Tool-holder in Operation on 3-inch Hole

with this tool and a counterbore can be dispensed with in most cases when the bottom of the hole in the piece is flat.

The cutting tool proper is made from high-speed steel with a hole through its center, so that the cutting edge is thoroughly flooded with cutting oil or compound. This tool is cheaper to make than a drill and can be used for making different sizes of holes, and also as a reamer. Fig. 12 shows the tool in operation, producing a hole that is three inches in diameter. Fig. 10 shows the kind of chips produced with this tool, and the set-over arrangement is also clearly shown. The holder carrying the cutting tool is mounted on a slide which is adjustable at right angles to the axis of the spindle by means of a collar-head screw, as illustrated. This adjust-

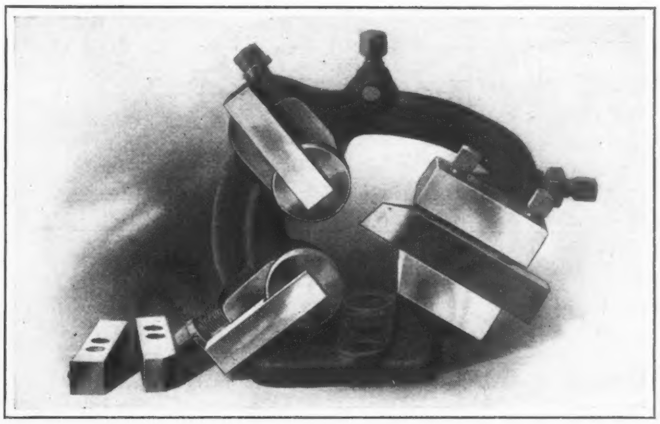


Fig. 13. Standard Type of Turner for Use on Gridley Automatic Turret Lathe

ment is made to secure the desired diameter of the hole in the work.

Internal Necking Tool

When it is necessary to make a recess in a hole so as to obtain a bearing at both ends, an internal necking or recessing tool of the type shown in Fig. 16 is used. This tool consists of a base *A*, which is clamped to the turret slide, as shown, and fulcrumed on this base at *B* is the main tool-holder *C*. This holder carries the recessing tool, which is held by a bushing and a clamping screw, as shown. The recessing tool is centered with the hole by means of the adjusting screw *D*, which has a collar head that comes up against the bracket *E* of the holder, and it also is provided with a nut for locking purposes. The shoulder of screw *D* is kept against the bracket by means of coil spring *F*, and after the tool has finished cutting, and the pressure is removed from the holder, the spring returns the tool to the central position. The recessing tool is fed to depth by means of a roller pusher *G* mounted in a bracket *H* attached to the edge of the forming slide, as illustrated. The roller bears against a hardened block that is held by screws to the side of the internal necking tool-holder proper. In using this tool for enlarging, or boring a hole, it is necessary, of course, to so arrange the forming cam that the forming slide will be advanced at the proper moment, dwell until the length of bore has been completed, and then be withdrawn. In recessing for a thread or internal form, it is necessary to advance the turret slide and dwell until the forming slide has been fed in to the required depth.

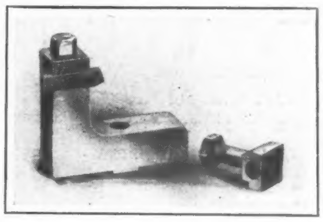


Fig. 14. Knee Turner for Roughing and Finishing Cuts

An internal forming or recessing tool that differs slightly from that shown in Fig. 16 is illustrated in Fig. 11. The design in this case is not quite so elaborate; the tool is operated from the forming slide in a similar manner to that shown in Fig. 16.

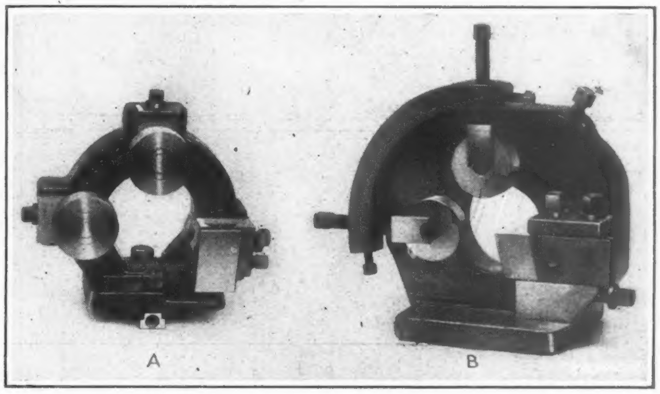


Fig. 15. Standard Turners used on $4\frac{1}{4}$-inch Gridley Automatics

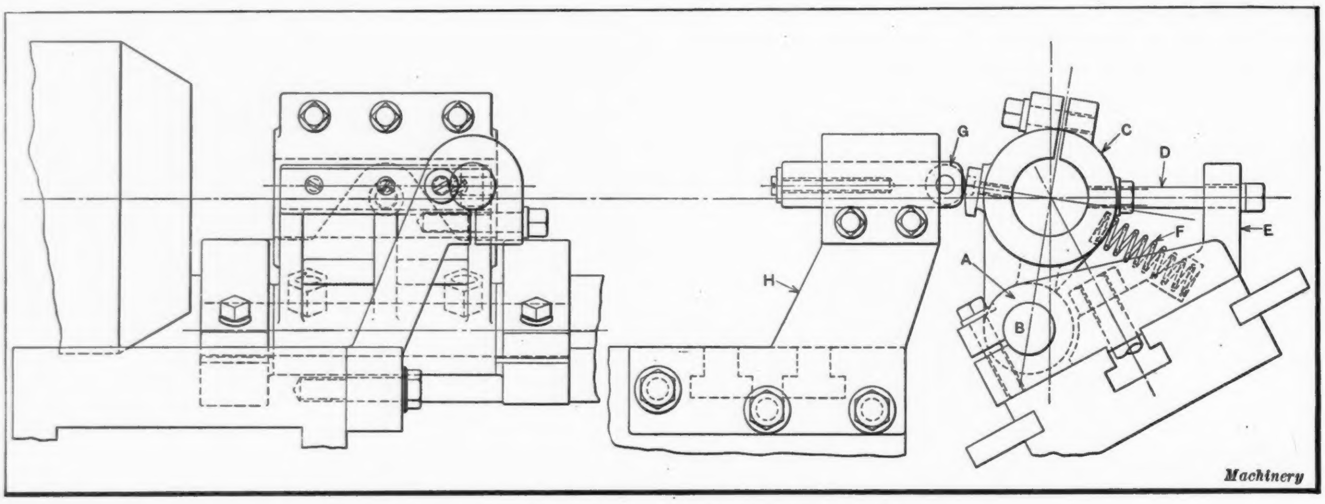


Fig. 16. Another Type of Internal Necking or Recessing Tool-holder

Turners and Back-rests

A noticeable feature of the standard turning tool shown in Fig. 13 is the absence of a shank. This holder is in the form of a yoke having a base that is rigidly clamped to the turret slide. At the front it carries a turning tool and at the rear two supports; the latter can be either of the plain type or of the roller type, as shown. The cutting tool in the turner for the 2¼-inch machine is 1 by ½ inch and is ground on the end, as shown. The roller rests permit the use of heavier cuts and coarser feeds, and a cutting speed of two or three times that which can be maintained when the common type back-rest is used. These back-rests may be used either ahead of or behind the cutting tool, depending upon the character of the work and the cut being taken.

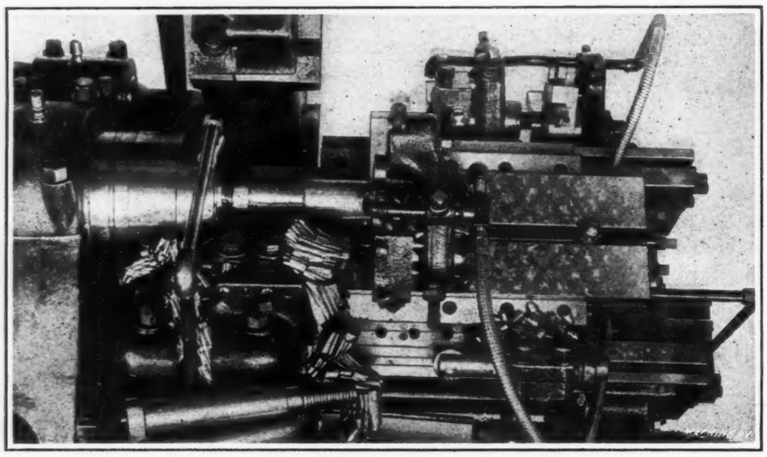


Fig. 17. Standard Turner and Flat Forming Tool working together on Shoulder Screw

Fig. 17 shows one of these standard turners at work producing a shoulder screw with the forming tool at work at the same time. Forming and turning can be done simultaneously with good results, as the desired rigidity can easily be obtained. This particular setting was used to save time on the single-spindle machine, but if the same job were done on the multiple-spindle machine, two or more turning cuts would be made, thus obviating the necessity for the wide forming cut in the first operation. The same illustration also shows the adjusting screw for moving the standard tool-holders in a longitudinal direction along the turret slide, to which reference has been made in the foregoing.

At *A* and *B*, Fig. 15, are shown two types of standard turners used on the 4¼-inch automatic turret lathe. The one shown at *A* uses a dovetail turning tool, whereas that illustrated at *B* uses a forged tool. In both cases adjustable roller supports are used.

Another type of standard turner, known as an "adjustable stud turner," is shown in Fig. 18. This turner is so arranged that three different diameters can be finished at the same time. It consists of a holder proper, which is clamped to the turret slide and carries individual units, one unit for holding the cutting tool and the other for the back-rest or support. Usually the first support of the group is provided with rollers because of the heavier duty required in this position. The turning tools are adjusted by means of a collar-head screw, as illustrated, and adjustment is also provided for the back-rests.

Fig. 19 shows a special stud turner. This is almost of the same design as the adjustable stud turner, except that it is made for a given piece of work and is not adjustable for shoulder distances, that is, longitudinally. The tool-holder proper is solid, as illustrated, and carries, in this case, five turning

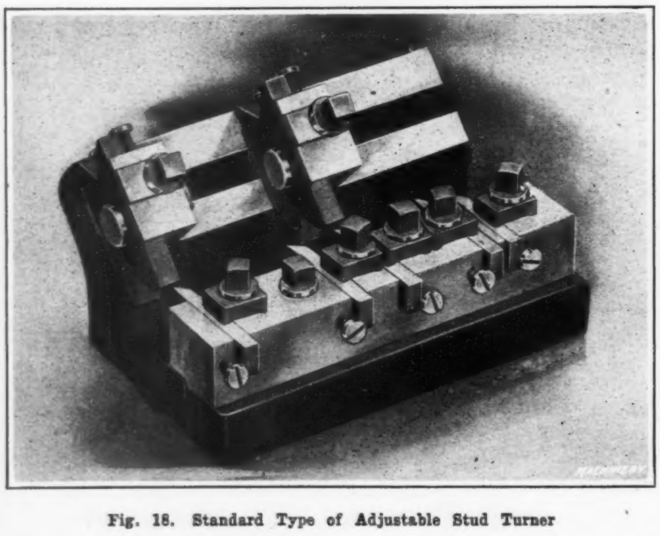


Fig. 18. Standard Type of Adjustable Stud Turner

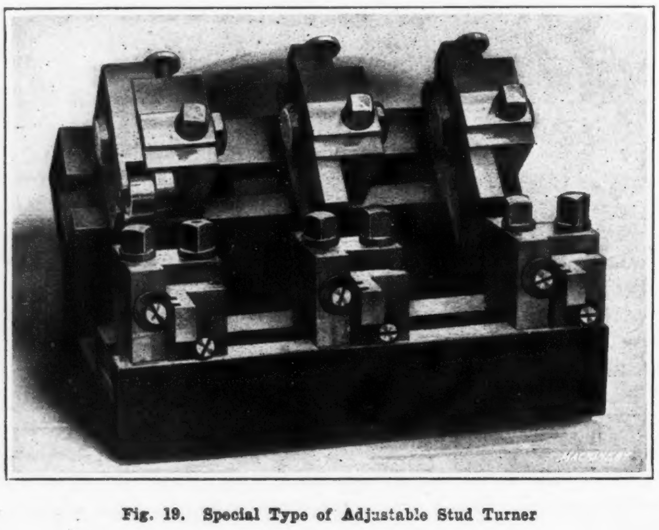


Fig. 19. Special Type of Adjustable Stud Turner

tools. The supports are held so that they can be adjusted along the slide or holder to bring them in the most convenient position relative to the work, that is, where they can give the best support. When the required number of pieces have been made, this tool is put away without disturbing the cutting tools and can be kept until the same piece is to be produced again. In the arrangement shown, it is possible to put the cutting tools much closer together than in the holder shown in Fig. 18.

Knee Turner

Fig. 14 shows a type of tool known as a "knee turner," which can sometimes be used to good advantage for removing scale from the work by preceding the drill, reamer or other tool being used. It is narrow, so that it takes up very little space, and can be used in conjunction with some other tool. It cuts on the back side of the bar, so that the forming tool can be operated without backing off the knee turner from the work to get it out of the way.

Feeds and Speeds for Turning

The feeds and speeds used on the Gridley turret lathe when using the standard turners vary considerably and are governed entirely by the material and nature of the cut. Because of the rigidity of the machine, it is generally advisable to use a coarse feed and a comparatively slow speed. This statement applies especially in the production of studs or other work when the amount of metal to be removed is considerable. When only light cuts are to be taken, however, it is preferable to increase the speed and decrease the feed, although, as a general rule, the speed can be increased without any corresponding decrease in feed and still give satisfactory results, owing to the elimination of chatter. Each different piece, however, requires a careful analysis of the conditions to be met in order to determine exactly what feed and speed should be used.

* * *

GRINDING-WHEEL GRADES

"Grade" is a word used to designate the relative hardness of any given grinding wheel. Different methods of indicating grade are in use, the most common employing the letters of the alphabet. One company uses the first letters of the alphabet for the harder grades, the middle letters for the medium grades, and the last letters for the softer grades. Another company uses just the reverse of this method, while others use a system based upon some particular word. Grade is determined by measuring the resistance which a wheel offers to the penetration of a small steel tool resembling a screwdriver. The wheels under inspection are compared with wheels of known hardness, so that all variable factors are reduced to a minimum. The belief is quite common that a grade is an exact value. A grade is not an exact value—it is a range between limits, and all wheels that come within this range are of one grade and carry the same grade letter. A test was made to determine the hardness of each grade as indicated by the tensile strength. A lot of wheels all of the same dimensions and the same size of grain, but of different grades, were slowly speeded up to a point where centrifugal force became greater than the tensile strength of the wheel, and breakage occurred. The number of points per square inch tensile strength to which each wheel was subjected was calculated, and from these figures the following results were plotted: The tensile strength of grade O, Norton scale, ranges between 2100 and 2050 pounds per square inch; grade N, between the limits of 2050 and 1975; grade M, between 1975 and 1875; grade L, between 1875 and 1790; grade K, between 1790 and 1700; grade J, between 1700 and 1600.—*Condensed from talk by R. G. Williams of the Norton Co.*

* * *

The firm of Isaac Best & Co., Ltd., Newton Heath, Manchester, England, recently made what is claimed to be the longest twist drill ever produced. The length of the drill is seven feet. No statement is made of the object of making so long a drill. The makers are patentees of machines for fluting twist drills and reamers and for backing off such tools, and possibly the drill was made merely for advertising purposes.

THE TUMBLING BARREL

BY G. R. SMITH[1]

One of the oldest and simplest metal-working devices, and perhaps the most useful in its field, is the tumbling barrel. Its operation requires but a small amount of power and the attention of one unskilled workman. The idea involved is not of recent date; it is as old as mankind itself, being simply an adaptation of the oldest of all ideas for cleaning. Have you ever seen your grandmother clean the inside of a stained bottle by shaking in it a few small stones and a little water? That is the principle. The Aztecs cleaned and polished their gold trinkets by placing them in a gourd with a little fine sea sand sifted through bits of porous hides and then shaking the gourd until the gold was clean and bright. The trinkets were brought to a still brighter state by replacing the sand with dry fish scales and again shaking. That is the tumbling barrel in its first form; both the idea and the materials used to help the process and get the desired results are old. In a study of the habits and customs of the savage tribes all over the globe, the same idea is found time and time again; we have simply commercialized it for our use.

About the first tumbling barrel of real commercial value was made by an English inventor, William Lee, between 1585 and 1590; it was used to clean the iron and steel parts of a machine for knitting stockings. The idea was speedily adopted until the tumbling barrel became widely known. Lee's barrel was a crude, hand-propelled apparatus, but the idea was brought out in such a way as to show at once its value. The idea involved, however, is not the product of a certain train of thought, as is the case with many inventions, but rather the development of Nature's own bent. Perhaps the simplest people, the crudest minds, received the idea from seeing the stones whirled around in the pot-holes in the rocks of the streams and rivers receiving a polish by the constant motion caused by the flow of water; be that as it may, the idea is old, simple, cheap and effective.

According to the dictionary, the word tumble or tumbling means to fall suddenly, to roll about, to turn over, a rolling over. That explains the process and is exactly what takes place inside the tumbling barrel when it is in motion and what must take place to make the process a success. This is the one factor the writer wishes to bring out more than anything else. Each piece in the barrel rolls and falls over the other pieces, rubbing and chipping off whatever foreign substance may be clinging to the pieces with which it comes into contact. Whatever material, such as sand, sawdust, etc., may be placed in the barrel with the work is only to aid the process of cleaning; the falling motion of one piece over another is what does the work. If sand and cork, or sawdust, are used with heavy steel work, the sand helps the cleaning process, and the cork, or the sawdust, absorbs the dust that comes from the process and in a way helps to polish the work. If sawdust alone is used, it lessens the severity of the blow of one piece against the others and helps the cleaning process.

Cleaning and Polishing Work by Tumbling

In all cases where tumbling is done to clean and polish the work, it is the falling and tumbling of each piece over the others that effects the cleaning and polishing, not the material that is placed in the barrel with the work. The work would clean itself if nothing were mixed with it; therefore, no matter what may be the nature of the work being tumbled, sufficient space must be left in the barrel for it to do its work. Nothing at all will be accomplished if the barrel is filled too full of work or the work mixed with so much sawdust, sand or cork that it is mechanically impossible for the pieces of work to strike against one another. One rule that may be laid down for all classes of work and all sizes of barrels is that the work to be tumbled and the material used to help the process, such as sawdust, etc., should not occupy more than one-third the space inside the barrel, while one-fourth the space is a better ratio to insure success. Many foremen are making a success of tumbling operations by placing in the barrel nothing but the work to be tumbled.

[1]Address: 19 Pond St., Pittsfield, Mass.

So varied is the procedure to get different results on different classes of work that it is out of the question to lay down a set of prescribed rules. Small work, such as very thin sheet-brass blanks, copper blanks, etc., should not be tumbled at all. The same result may be secured much more quickly and at less expense by pickling or the bright dip. There should be little necessity for tumbling punched parts of this kind, for if the blanking tools are kept in shape and ground, there will be no burr, and certainly they should not need annealing in the blank. Small brass and copper castings or drop-forgings may, if really required, be cleaned by tumbling in sand.

One cause of failure is the allowance of insufficient time in which to obtain the desired results. All work must be run until thoroughly treated, whether it takes one hour or ten. The operation costs next to nothing, but it must continue until the result is reached. Nothing can hurry the process and the results of six hours' tumbling cannot be expected in one hour. Another cause of poor results or failure is the amount of sand or sawdust used in proportion to the work. In tumbling five cubic feet of work the writer would not mix more than one and one-half to two cubic feet of sand, sawdust or cork. This must be measured by volume, or quantity, and not by weight, as that is another cause of failure; the sand, sawdust and work will weigh in greatly varying proportions.

Copper and brass punched parts are successfully tumbled for burrs in soft-wood sawdust in from two to four hours. Steel and iron parts may be tumbled in sea sand for burrs, scale in annealing, etc., in from three to six hours' run. Burrs and annealing scale have been removed from steel blanks, say 4 to 6 inches in diameter and 1/8 inch thick, in a five-hour run, with a mixture of sea sand and scrap cork (say two parts cork to two parts sand, by volume, not weight), and this mixture run dry in a ratio of 1 to 4 or 1 to 5 of the steel blanks. Steel blanks 6 inches in diameter and 1/8 inch thick have been tumbled to a good bright finish in a five hours' run in a barrel of one cubic yard capacity, using one-third as much pure sand as work and the whole load being but three cubic feet. Punched copper commutator segments have been successfully tumbled for burrs in a three hours' run in a barrel of one cubic yard capacity, using one-third as much pine sawdust as work and loading the barrel about half full. Machine-steel punched hinge parts that have been annealed and formed have been tumbled for burr and annealing scale and brought to a bright finish in a six hours' run in a one-cubic-yard barrel, using one-fourth as much pure sand as work and limiting the load to three cubic feet. Green-clay and sand molded castings have been successfully cleaned in a four hours' run in a two-cubic-yard barrel, nothing being placed in the barrel but the castings, and loading to one-third its capacity.

Partly finished or partly polished steel goods are often successfully tumbled in scrap leather to get a higher polish; this is simply an adaptation of the Aztecs' idea of shaking gold trinkets in a gourd with dry fish scales. The waste shavings and dust that come from the manufacture of fiber parts are also used for tumbling steel goods. In fact, all materials used to help the tumbling process should be, and generally are, wastes from other manufactures.

Silver plating has been done in the tumbling barrel by mixing a heavy mixture of chloride of silver, water and common salt with granulated cork. Small brass parts tumbled in this mixture take a very good plate in from one to three hours. The process is simply the rubbing of this mixture on the brass goods by the granulated cork.

The polishing or glaze mill used in the manufacture of rifle powders is nothing but a tumbling barrel. It is a polished, maple-lined barrel, into which is placed a quantity of powder as it comes from the corning mill; the falling motion of each grain over the others gives it the deep glazed luster.

Wooden handles, knobs, etc., are successfully cleaned and smoothed by tumbling with bits of torn sandpaper, a common oil barrel hooked up on a shaft being generally used. The writer has given a good manufacturing finish, in two hours' run in a sixty-gallon oil barrel, with twenty-four sheets, 10 by 12 inches, of torn sandpaper, medium grade, loading the barrel to one-third its capacity. This gives a good finish for dipping in asphaltum or white enamel broken up in gasoline.

Horn goods, clam- and oyster-shell novelties, bone products, etc., are cleaned and polished by tumbling. They are seldom mixed with any other materials.

All woods, most metals and many compositions may be successfully tumbled for cleaning and polishing. The type of tumbling barrel used has little to do with the process, as one barrel is as good as another, except perhaps in convenience The speed of the barrel is, of course, an important item; it must not be run so fast as to carry the work around in a solid mass, and it must be run slow enough for the pieces to fall and tumble over one another. To be effective, the barrel should make from thirty to sixty turns a minute. Personal judgment and experience must establish the rule in each individual case. In no case should work be tumbled if the same result can be reached more quickly and cheaply by other means, nor should work be dipped, pickled, scratch-brushed or polished that can be satisfactorily tumbled.

* * *

USE OF FORMED SOLDER

In manufacturing articles having many soldered joints difficult to reach, it is good practice to furnish the solder punched or formed to fit the seam, as the time, labor and solder saved are important considerations; moreover, the formed solder is more likely to reach every part of the seam and insure a tight joint.

Fig. 1 shows a solder link stamped from a thin sheet of solder which is used by the Ford Motor Co. in making radiators of the tubular type. The radiator element is built up of vertical rows of tubes pressed through thin copper plates. The ends of the tubes must be soldered tightly into the water chambers. The solder links are dropped over the ends of the rows of tubes and are melted with a blow-torch, as shown in Fig. 2. The solder, being applied all around the tube in link form, runs down the tube to the tube sheet and makes a practically perfect soldered joint on five tubes simultaneously. It is obvious that much time is saved by the use of formed solder links in confined spaces like this; in fact, it would be practically impossible for the workman to apply solder to all the tubes in a reasonable length of time unless it were furnished him in the stamped shape.

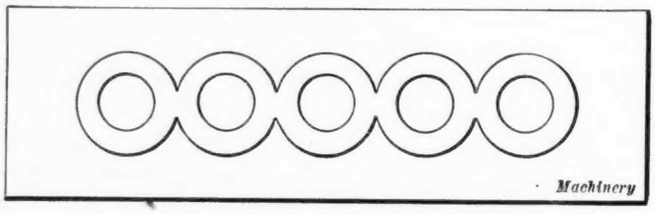


Fig. 1. Solder Link used in making Ford Radiators

Fig. 2. Soldering Vertical Tubes in Water Chambers of Ford Radiators

SPECIAL-PURPOSE TURRET LATHE WITH BALL-BEARING SPINDLE

BY T. S. MACEWAN [1]

A heavy-duty, 32-inch turret lathe, recently designed by Charles H. Hollup and built by the Vilter Mfg. Co., Milwaukee, Wis., is shown in Fig. 1. The details of the headstock design were given the most careful consideration, with the result that ball bearings were used on the spindle and a cone clutch was provided for quickly throwing the back-gears in and out.

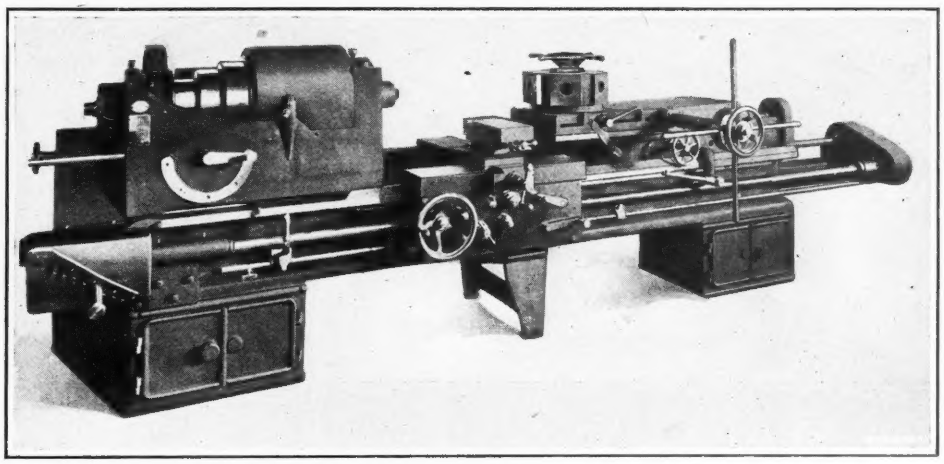


Fig. 1. Heavy-duty 32-inch Turret Lathe

A lathe, to be a profitable investment, must be capable of producing properly machined pieces day in and day out with the minimum of attention. This means that the working spindle must be held rigidly and must be free from chatter under operating conditions, and it must be mounted to withstand the tool pressure and thrust imposed. To produce good work, a spindle bearing must be free from shake and hold the spindle tight. A great many people claim that it is impossible to keep a bearing in this condition for any length of time without adjustment, and that wear begins at the time of starting, soon resulting in looseness. While a countershaft bearing, or a bearing for any kind of shaft that does not carry a cutter or work that is being cut, can be slightly loose without serious effect, in a spindle where smooth work is expected, absolute tightness must be preserved. This rigidity of the spindle not only eliminates chatter where heavy cuts are taken with single-point tools, but permits a light finishing cut to be taken with a wide shaving tool. Further, any shake during the cut due to the varying cutting depth of the tool is prevented.

In Fig. 2 it will be seen that the front bearing surfaces of this turret lathe comprise two S K F double-row, radial, self-aligning ball bearings mounted in a through bored housing, with end caps bolted to the frame to make an enclosed type of bearing combination. The machining of parts is simplified and greater ease in erection is secured through the use of ball bearings. Two ball bearings are also located in the three-step cone pulley, which is bored to correspond with the outside diameter of a standard bearing. When running loose, the gear load for the driven gear mounted on the lathe spindle is taken by one of these bearings.

The operating thrust load, of which there is a small component in turning and a heavy one in boring work, is taken on the set of balls of the double thrust bearing mounted at the rear of the spindle. Where the turning is done toward the direction of the tailstock, the thrust is in the opposite direction to the forward thrust, and the load is properly taken care of by the reversal of the double thrust bearing and the assumption of the load by the other set of balls. When the back-gears are to be brought into play the clutch is thrown in so that gear *A* drives the corresponding back-gear. With direct drive the clutch is thrown in the opposite direction, so that the cone pulley drives directly through the spindle to the work. The cross-feed screw of the carriage is provided with a thrust ball bearing, by means of which undue wear and the resulting lost motion are eliminated.

[1] Address: S K F Ball Bearing Co., Hartford, Conn.

* * *

Methods employed in manufacturing are sometimes directly opposite in principle to those that would naturally be followed when making the parts by hand one at a time. These manufacturing methods have been adopted because they overcome difficulties of handling and promote rapid production. For instance, in making motor car top curtains, the Ford Motor Co. follows the practice of sewing the celluloid windows to the fabric before cutting the openings. The fabric holds its shape during the sewing operation and there are no holes to catch on the machine and interrupt the operation. When the sewing is done, the openings are cut with a sharp forked knife which slides over the celluloid and cleanly cuts or rips the fabric close to the seam. This method not only saves the sewing operator's time, but also permits the openings to be cut much more evenly and expeditiously than would be possible by following the reverse and natural process.

* * *

In order that German letters patent issued to American citizens shall not lapse because of the non-payment of taxes, or other necessary fees, a recent presidential proclamation permits such payments to be made throughout the duration of the war.

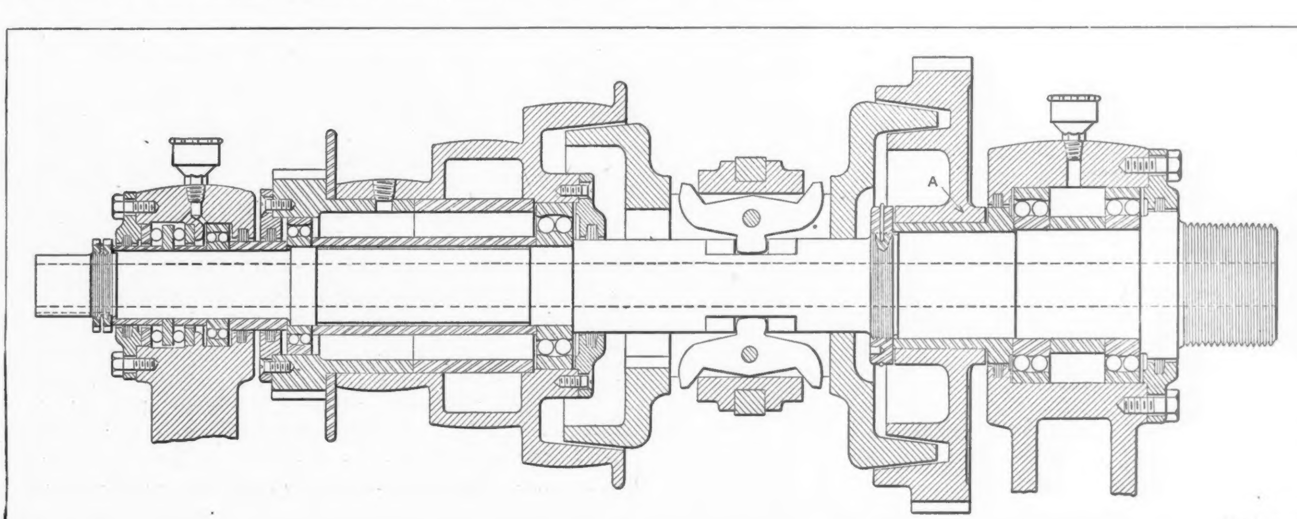


Fig. 2. Spindle of Special-purpose Turret Lathe

INDUSTRIAL OXYGEN EXPLOSIONS

CAUSES OF RUPTURE OF STORAGE CYLINDERS USED IN WELDING AND CUTTING OPERATIONS

BY EDWARD K. HAMMOND[1]

DURING the period in which oxy-acetylene welding and cutting were in process of development, the explosion of an acetylene generator was not an unusual occurrence, accidents of this kind being due to generators of unsuitable design and improper methods of handling the gas. An increase of knowledge on this subject was the means of practically eliminating these sources of danger. Recently there have been several serious explosions of oxygen used in connection with acetylene in the welding and cutting of metals. It has become a matter of general knowledge that acetylene must be handled with care, but many users of oxy-acetylene torches do not realize that there are dangers connected with the use of oxygen of unknown purity, and, as a result, serious accidents are likely to occur. This is due in part to the fact that some manufacturers of electrolytic oxygen generators have unwisely advertised the statement that their machines are fool-proof and can be safely operated by laborers of average intelligence. This may be the case so long as everything goes properly, but it requires a particularly intelligent attendant to detect an abnormal condition of operation before a lot of dangerous gas has been generated and sent out to the welding shop. An inquiry made by MACHINERY to ascertain the different sources of danger connected with the use of commercial oxygen or the operation of electrolytic oxygen generators, and the precautions that should be taken to avoid accidents from these causes, has revealed the information outlined in the following article.

In starting upon this discussion, attention is called to the fact that commercial oxygen may be produced by either of two processes. The first is generally known as the liquid air method, which consists of liquefying air by the application of pressure and reducing the temperature, and then separating the oxygen from the nitrogen by taking advantage of the difference in boiling points of the two liquids. Oxygen produced in this way cannot explode through the presence of impurities, because these impurities are nitrogen and other gases which are chemically inert. The second method of obtaining oxygen is by the electrolysis of water, and here there is a possibility of accidents due to hydrogen being present in sufficient quantity to make a mixture that is highly explosive. This danger is theoretical rather than practical, so long as the proper precautions are taken in the operation of electrolytic generating plants; but where there is lack of care in attending to generators or where the generators are of unsuitable design, this danger may prove serious.

Theoretically, the explosion of a mixture of hydrogen and oxygen results in the combination of two volumes of hydrogen gas with one volume of oxygen; but while this is the mixture required for a complete explosion, experience has shown that there is a wide range of mixtures that constitute what may be called a danger zone, *i. e.*, mixtures that may explode with violence under certain conditions. This question was considered of sufficient importance to warrant an investigation being undertaken at the Pittsburg Laboratory of the Bureau of Mines, where it was found that mixtures ranging from 9 per cent of hydrogen and 91 per cent of oxygen up to 92 per cent of hydrogen and 8 per cent of oxygen were likely to give trouble. This is more liberal than limits established by the Davis-Bournonville Co., Jersey City, N. J., a well-known manufacturer of welding and cutting equipments, including oxygen generators. In this company's laboratories the danger zone was found to cover a wider range, extending from 6 per cent of hydrogen and 94 per cent of oxygen down to 97 per cent of hydrogen and 3 per cent of oxygen. The idea of this danger zone will be best understood by reference to the tabulated figures, the brackets representing the range of explosive mixtures. Here it will be evident that mixtures of hydrogen and oxygen represented by the high and low limits, and all mixtures coming between these limits, may be made to explode under suitable conditions.

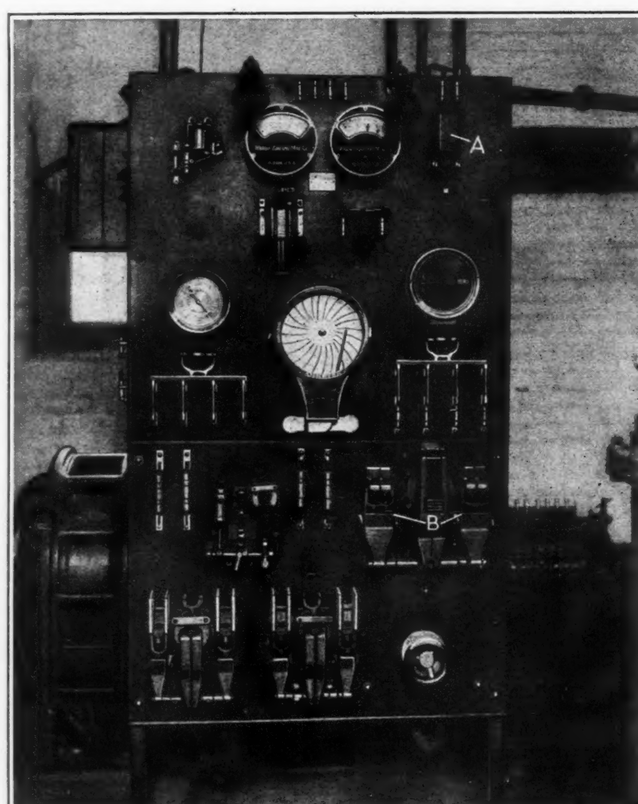


Fig. 1. Switchboard equipped with Automatic Switch to prevent Reversal of Polarity of Generator

Oxygen	Hydrogen
100	0
98	2
96	4
94	6
91	9
8	92
6	94
3	97
2	98
0	100

Note—Brackets inside the columns represent range of explosive mixtures, as determined by Bureau of Mines; and brackets outside the columns cover range of mixtures found to be explosive by the Davis-Bournonville Co.

Investigations conducted with the view of determining the cause of oxygen explosions that have resulted disastrously have led to certain important modifications in the design of electrolytic generators and auxiliary equipments to prevent the recurrence of such accidents. In the operation of an electrolytic cell, decomposition of water results in liberation of hydrogen at the negative electrode of the cell, while oxygen passes off from the positive electrode. The cells are so arranged that gas collected from each of these electrodes is passed into containers provided for the hydrogen and oxygen, respectively. Should it happen that the polarity of the generator is reversed, it would result in a corresponding reversal of the polarity of the cells, so that oxygen would be collected in the container provided for hydrogen, and *vice versa.*

As a matter of fact, this has been the cause of some serious accidents, and a study of the subject led to the provision of safety devices which make it impossible for trouble of this kind to occur. The safeguard consists of an automatic switch, which makes connection with the electrolytic cells only after the generator has reached normal speed and is developing its normal electromotive force. The necessity for this provision arises from the fact that at any time when the operation of a generator is stopped there is a tendency, while the armature is still turning over by inertia, for a counter-electromotive force to be built up in the cells. This may reach sufficient proportions to overcome the magnetic force of the field windings

[1]Associate Editor of MACHINERY.

of the generator, so that when it is again started the generator will operate with its polarity the reverse of normal and supply energy of a correspondingly reversed polarity to the electrolyzers.

Should such a condition exist, it is obvious that hydrogen would be delivered to the oxygen gas-holder and oxygen to the hydrogen gas-holder, thus forming a dangerous mixture with the gas already in these holders. But with the automatic switch referred to, there is no danger of this trouble, because the generator will have assumed a normal speed and developed its normal electromotive force before the switch can be closed to allow current to pass through the cells. This method of safeguarding the connecting of the electrolyzers to the power supply makes it impossible for a counter-electromotive force in the cells to overcome residual magnetism in the windings of the generator. In the switchboard illustrated in Fig. 1, the switch shown at *A* is for making connection between the generator and cells, and is automatically closed by magnetic coils *B* when the generator speed and voltage have reached the normal figure. When the electric generator is stopped, the circuit through the electrolytic cells is automatically broken.

To further assure against trouble from a counter-electromotive force in the electrolytic cells due to causes outside the plant, such as the reversal of phase in the motor supply circuit, transposition of connections at the electrolytic cells, etc., use is made of a polarized relay connected to a special shunt. This provides for opening a single-pole relay in the control circuit, and the only way in which this circuit may be re-established is to close the relay by hand, provided the polarity has been restored to normal. If a plant is equipped with this system of control, reversal of polarity is indicated by failure of the electrolytic cells to operate. It is important to note that the generator used in connection with electrolytic cells should be of the shunt-wound type, because with compound-wound generators there is greater danger of reversal due to the counter-electromotive force in the cells passing through the series turns.

In addition to danger of the generation of explosive mixtures of oxygen and hydrogen through a reversal of polarity of the generator, trouble may also be experienced through improper connection of the terminals of electrolytic cells. As a matter of fact, this was the cause of a serious explosion which occurred in St. Louis some time ago. With the view of preventing accidents of this kind, the Davis-Bournonville Co. and other manufacturers of electrolytic cells have designed their electrical connections in such a way that it is impossible to connect them with the wrong polarity.

There is only one way to be sure that the purity of oxygen generated in electrolytic cells is up to the required standard, and that is by making chemical analyses at intervals of at least two hours. As a matter of fact, these analyses are simple to make and do not call for extensive technical knowledge of chemistry. Several methods are employed, the most common one being that of measuring one hundred cubic centimeters of gas into a burette and then running this gas over into another burette in which the hydrogen is burnt out by a platinum coil, which is raised to a red heat. The gas is then returned to the first burette and again measured, the contraction in volume expressed in cubic centimeters representing the percentage of hydrogen in the gas.

Other methods of determining the purity of oxygen consist of running the measured volume of gas into a second burette containing either pure metallic copper or sticks of phosphorus. Both these materials have the power to absorb oxygen from the mixture of oxygen and hydrogen, and after this absorption has been completed, the hydrogen is returned to the burette and measured. The contraction in this case represents the percentage of oxygen present. Standard apparatus can be purchased for making all these tests. In practice, it is customary to get a purity of 99.7 to 99.8 per cent for hydrogen and a purity of about 99.5 per cent for oxygen. If the purity of hydrogen runs below 99.5 per cent or the purity of oxygen is found to be below 99 per cent, it is considered that the generator is operating unsatisfactorily, and the man in charge of the station immediately proceeds to look for the cause. Where this precaution is taken, there is little danger of trouble from the use of electrolytic oxygen, because a high factor of safety is provided.

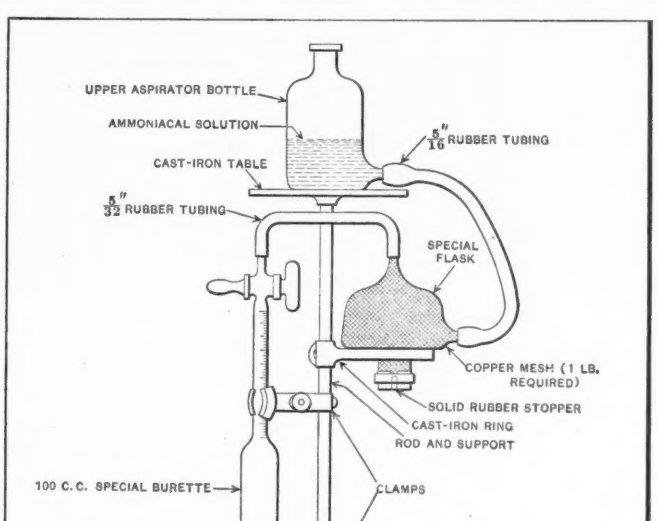


Fig. 2. Apparatus for determining Purity of Oxygen by Absorption with Metallic Copper

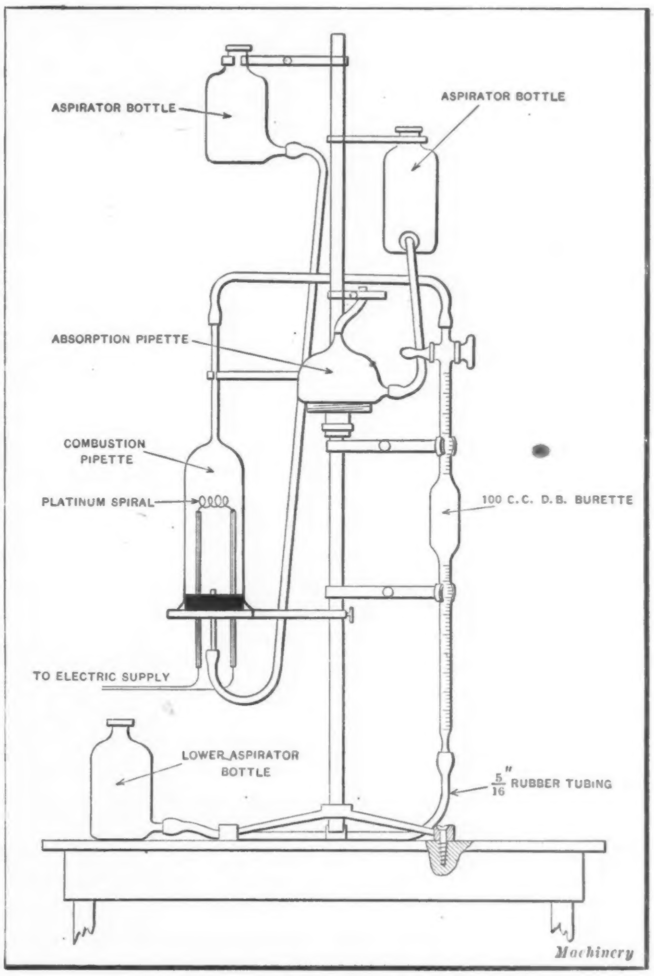


Fig. 3. Apparatus for determining Percentage of Hydrogen by Combustion Method, and Percentage of Oxygen by Absorption with Metallic Copper or Sticks of Phosphorus

Experience has shown that in the presence of oil there is danger of an oxygen cylinder "exploding" from what may properly be termed "spontaneous combustion" of the cylinder, although the gas is pure oxygen without any trace of hydrogen. This is due to the fact that the action of oxygen under high pressure—usually about 1800 pounds per square inch—results in oxidation of the oil, thus raising the temperature sufficiently to start the oxygen acting upon the iron cylinder, which is burnt away and allows the high-pressure gas to expand rapidly. This could not properly be called an explosion, because an explosion is usually understood to mean rapid combustion accompanied by rapid expansion. However, the condition that exists when the high-pressure oxygen is allowed to expand suddenly is similar to a true explosion, and the results have been serious in some cases. In this connection it is of interest to note that oxygen produced by the liquid air process and oxygen generated in electrolytic cells are equally likely to give trouble. Recently, the statement was made that this source of trouble could be eliminated by substituting graphite as a lubricant in place of oil, but experiments conducted by the International Oxygen Co., the Davis-Bournonville Co. and others show that graphite is just as dangerous as oil.

Still another hypothesis has been advanced as to a source of danger from the explosion of hydrogen. Reference has already been made to the fact that experimental data show that there must be at least 6 per cent of hydrogen in the oxygen to make the mixture explosive. This refers to 6 per cent of hydrogen uniformly mixed through the entire volume of oxygen. Readers of MACHINERY are doubtless familiar with the so-called kinetic theory of gases, otherwise known as the theory of uniform diffusion. According to this theory, the constituents of mixed gases are kept uniformly distributed, due to the kinetic action of molecules of the gas. For instance, a mixture of hydrogen and oxygen containing 3 per cent of hydrogen would have the hydrogen uniformly mixed through the 97 per cent of oxygen, and as it has already been mentioned that a minimum of 6 per cent of hydrogen is required to make the mixture explosive, it will be apparent that there would be no danger with this gas under normal conditions.

In practice, accidents have occurred through the explosion of oxygen cylinders in which the head has been blown out of the cylinder, and investigations conducted to determine the cause of these accidents have led to the belief that under the high pressure which exists in an oxygen cylinder—amounting to approximately 1800 pounds per square inch—the theory of uniform diffusion is not effective; it is assumed that under these conditions of pressure the gases settle out into strata, according to their specific gravities, the result being that the hydrogen rises to the top of the cylinder. This action may not be complete, but if there were a tendency for such settling out to occur, it could easily result in producing an explosive mixture of hydrogen and oxygen at the top of the cylinder, even though there were not sufficient hydrogen to make the entire mixture explosive. If such conditions can be developed, it is apparent that flashback or other cause of ignition would immediately ignite the mixture and result in the explosion of the gas in the cylinder. The theory is interesting, although it has not been definitely established by a carefully conducted scientific experiment. An accident of the same kind might also be produced through the action of oxygen on the oil used to lubricate the valve.

In handling oxygen cylinders, it should always be borne in mind that the gas is under high pressure, and as a result it requires intelligent care to prevent accidents. Cylinders should not be dropped or handled roughly, and they should not be placed so that they can be easily overturned either by collision with some other object or by the reaction due to the violent escape of their contents through the safety outlet with which each cylinder is provided. The valve regulating devices and other attachments should not be lubricated with oil for reasons to which reference has already been made. Discharge valves should be opened slowly and special care should be taken to avoid twisting or straining the valves by the use of hammers or improper wrenches.

Much valuable information has been gathered by members of the Committee on Production of Electrolytic Oxygen and Hydrogen which has been appointed by the Compressed Gas Manufacturers' Association, Inc., 120 Broadway, New York City, concerning possible dangers connected with the use of oxygen in the operation of cutting and welding torches. Distribution of information concerning the proper way to use oxygen and the safeguards that should be taken to avoid accidents will doubtless be the means of overcoming much trouble from this source.

* * *

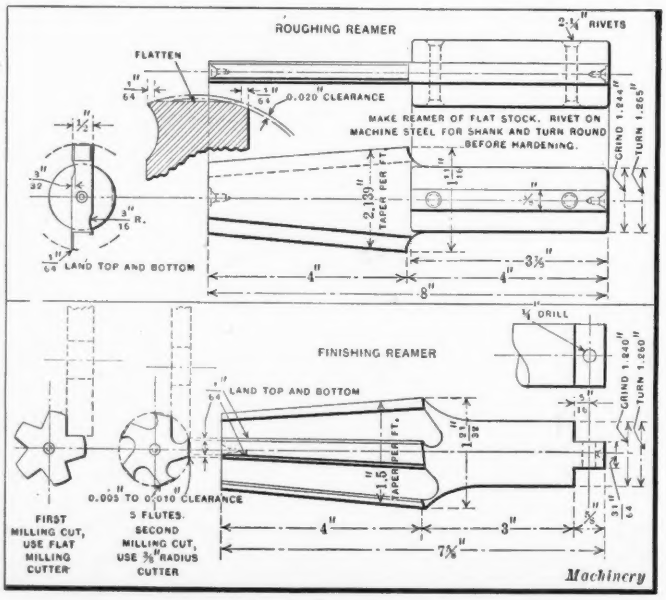
TAPER MACHINE REAMERS

The taper machine reamers shown herewith have been successfully used by the Brown-Lipe-Chapin Co., Syracuse, N. Y., by whom they were developed. The roughing reamer has two cutting edges, and the main body is made from a flat bar of steel, approximately ½ inch thick. After being cut to length, it is centered and turned to the desired contour. Two flat pieces of machine steel are riveted to the body to form the shank, and turned, leaving a sufficient amount for grinding. The chief difference between this taper roughing reamer and other types is the way in which it is ground and backed off. Just in front of the cutting edge a liberal radius is milled to a depth of 3/32 inch. This not only gives adequate clearance, but furnishes a well shaped surface for chips to slide upon. The taper is first ground accurately until the large end is of the correct diameter. After this, the curvature of the two flutes is flattened, leaving only 1/64 inch of the curved surface produced by grinding. Next the reamer is oscillated on the centers by hand and a clearance is ground radially on the edge back of the flute. The clearance in this case is 0.020 inch, as shown in the upper view of the illustration.

Finishing Reamer

The finishing reamer is five-fluted and is milled from a solid forging. Two cutters are used in milling the reamer. The first is a plain right-angle cutter, which is followed by one of ⅜ inch radius. The latter produces the under-cut, which makes these reamers so effective. After the reamer is ground, the flutes are flattened the same as in the roughing reamer. The radial clearance, however, on the back of each tooth is less than in the former case, varying from 0.005 to 0.010 inch. This reamer is fitted at the driving end so that it may float freely when in use.

An advantage that these reamers have over many others is the fact that they actually cut the metal rather than scrape it. Another advantage is the fact that it is impossible to crowd the reamers into the work enough to damage them, since the clearance is a known factor. The economy of the construction of the roughing reamer is worthy of note because of the high price of steel. V. B.



Details of Roughing and Finishing Reamer

PUMPS FOR OPERATING HYDRAULIC PRESSES

FORMULAS FOR DETERMINING SIZES OF ONE-, TWO- AND THREE-PLUNGER PUMPS

BY A. LEWIS JENKINS[1]

THE pressure required on the ram of a hydraulic baling press increases as the density of the bale increases. The pressure at the beginning of the stroke depends upon the density with which the material is packed in the baling box, and at the end, upon the amount that the bale is compressed. A similar variation takes place throughout the run of an unbalanced hydraulic lift, the required pressure increasing directly as the run of the ram.

Presses for baling cotton, hay and similar materials are usually supplied with water or some other liquid by a belt- or motor-driven pump. The speed and width of the belt are constant, and this means that there is a constant amount of power available, and the plungers of the pumps run at a constant speed. When the pump is provided with only one plunger, its diameter or area is determined by the final pressure required, its velocity and the available horsepower obtained from:

$$\text{H.P.} = \frac{pvz}{33{,}000 \times 12}$$

where H.P. = available horsepower;

p = maximum or final pressure in pounds per square inch;

v = velocity of plunger in inches per minute;

z = area of ram in square inches.

At the beginning of the stroke of the press ram, a very low pressure is sufficient to move it. Hence, it will be seen from the preceding equation that the power required to deliver the water at the beginning of the ram stroke is very small compared with the power required in producing the final pressure; and the time for one operation is much longer than it would be if the maximum available horsepower could be utilized throughout the entire stroke. This condition could be realized for all positions of the stroke of the baling press if it were possible to make pv a constant, where p is the pressure at any position of the stroke. This has been done to some extent by using a mechanism similar to the Stephenson link, which varies the length of stroke of the pump, making it shorter as the pressure increases, and thereby maintaining a constant required power. Other methods have been tried, such as placing two pump plungers in the same plunger box and adjusting their relative positions by shifting their eccentrics in such a way as to vary the effective displacement. The design of a pump which maintains a constant value of pv is more or less complicated, and such pumps are expensive to construct. The result is obtained by automatically varying the length of stroke or by changing the relative positions of the two plungers working in the same plunger box.

[1]Address: Department of Mechanical Engineering, University of Cincinnati, Cincinnati, Ohio.

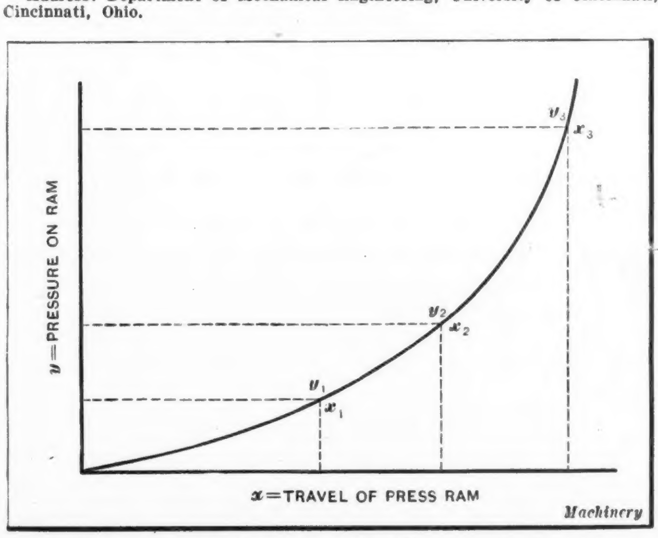


Fig. 1. Diagram illustrating Relation between Pressure of Pump Plungers and Travel of Ram of Press

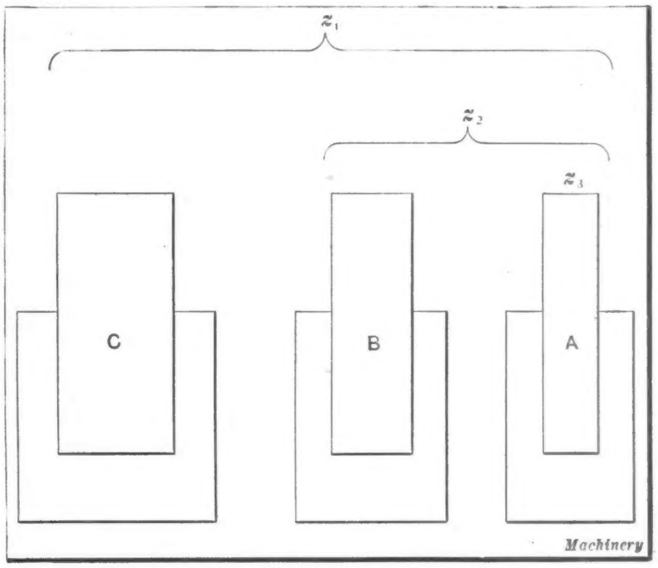


Fig. 2. Arrangement of Multiple-plunger Pump

Another method of maintaining a constant horsepower throughout the stroke of the press is effected by making pz constant; but this cannot be thoroughly accomplished in a commercial machine. An approximation of this method, however, has proved to be the most satisfactory solution. The time required for one operation may be decreased by using more than one plunger and automatically cutting out one at a time as the increasing pressure raises the power required to drive the pump with the active plungers in operation. Thus, a pump provided with three plungers having areas A, B and C, respectively, may have all three plungers in operation for a portion of the stroke of the press ram, and when the pressure times the area of all three of the plungers becomes sufficient to require all the available power, plunger C "knocks out" and A and B continue to operate until the power again becomes equal to the maximum and B "knocks out," allowing the plunger A to finish the operation, which requires the maximum pressure.

All of the plungers A, B and C may be made equal in area, and the pressure at which they should knock out may be determined; but for ordinary baling operations this is not the most economical proportion of plunger areas from the standpoint of available power and the time required to compress a bale. For baling cotton and similar materials the relation between the pressure per square inch on the ram and the travel of the ram in inches may be expressed by the equation:

$$y = kx^3$$

where y = pressure per square inch of the water acting upon the ram of the press after it has traveled a distance x from the beginning of the stroke, and k is a constant depending upon the area of the platen and nature of the material pressed.

Proportions of Plungers for Three-plunger Pump for Baling Cotton

It is desirable to have the plungers of such proportions that they will raise the ram of the press in a minimum time when a given power is available. The relation between pressure y and travel x is shown in Fig. 1, and a diagram showing the arrangement of the plungers of the pump is shown in Fig. 2.

Let z_1 = area in square inches of the three plungers A, B and C;

z_2 = area in square inches of the two plungers A and B;

z_3 = area in square inches of the plunger A;

v = velocity of the plungers in inches per minute;

y_1 = pressure in pounds per square inch at which C knocks out;

y_2 = pressure in pounds per square inch at which B knocks out;

y_3 = pressure in pounds per square inch at which A knocks out, or the final pressure required;

x_1 = distance in inches ram of press has traveled when C knocks out;

x_2 = distance in inches ram of press has traveled when B knocks out;

x_3 = distance in inches ram of press has traveled when A knocks out, or total travel of press ram;

M = area of press ram in square inches;

t_1 = time in minutes the plunger C operates, or time the area z_1 is in action during working stroke of the press ram;

t_2 = time in minutes the area z_2 is in action during the working stroke of the press ram;

t_3 = time in minutes the area z_3 is in action, or the period during which only the ram A is operating during the working stroke of the press ram;

T = total time in minutes required for the working stroke of the press ram $= t_1 + t_2 + t_3$.

The volume displaced by the press ram for any position, a distance x from the beginning of the stroke, is Mx. The volume displaced by area z_1 of the pump plungers for a travel x_1 of the press ram is Mx_1. The pump plunger area z_2 is in operation while the press ram travels from x_1 to x_2; hence, the volume displaced by z_2 is equal to $M(x_2 - x_1)$. Similarly, the volume supplied by z_3 is $M(x_3 - x_2)$.

Substituting the values of x given by the following equation:

$$y = kx^3 \text{ or } x = \sqrt[3]{\frac{y}{k}}$$

we have:

$$Mx_1 = M\sqrt[3]{\frac{y_1}{k}} = \text{volume supplied by area } z_1;$$

$$M(x_2 - x_1) = M\left(\sqrt[3]{\frac{y_2}{k}} - \sqrt[3]{\frac{y_1}{k}}\right) = \text{volume supplied by area } z_2;$$

$$M(x_3 - x_2) = M\left(\sqrt[3]{\frac{y_3}{k}} - \sqrt[3]{\frac{y_2}{k}}\right) = \text{volume supplied by area } z_3.$$

The time t in minutes required to raise the press ram a distance x with one plunger having an area z and velocity v is:

$$t = \frac{\text{volume displaced by press ram}}{\text{rate of flow of water from pump}} = \frac{Mx}{zv}$$

By substituting the value of x given by the equation

$$x = \sqrt[3]{\frac{y}{k}}$$

we get:

$$t = \frac{M}{zv}\sqrt[3]{\frac{y}{k}} = \frac{m}{z}\sqrt[3]{y}$$

where $m = \dfrac{M}{v\sqrt[3]{k}}$ = constant;

Similarly,

$$t_1 = \frac{m}{z_1}\sqrt[3]{y_1} = \text{time area } z_1 \text{ is in action}$$

$$t_2 = \frac{m}{z_2}(\sqrt[3]{y_2} - \sqrt[3]{y_1}) = \text{time area } z_2 \text{ is in action}$$

$$t_3 = \frac{m}{z_3}(\sqrt[3]{y_3} - \sqrt[3]{y_2}) = \text{time area } z_3 \text{ is in action}$$

Hence, the total time T required to raise the press ram is:

$$T = t_1 + t_2 + t_3 = \frac{m}{z_1}\sqrt[3]{y_1} + \frac{m}{z_2}(\sqrt[3]{y_2} - \sqrt[3]{y_1}) + \frac{m}{z_3}(\sqrt[3]{y_3} - \sqrt[3]{y_2}) \text{ minutes}$$

In order to have the power equal at pressures y_1, y_2 and y_3:

$$y_1z_1 = y_2z_2 = y_3z_3$$

By multiplying the numerators and denominators of respective terms on the right of the equation for T by y_1, y_2 and y_3 gives:

$$T = \frac{my_1}{z_1y_1}\sqrt[3]{y_1} + \frac{my_2}{z_2y_2}(\sqrt[3]{y_2} - \sqrt[3]{y_1}) + \frac{my_3}{z_3y_3}(\sqrt[3]{y_3} - \sqrt[3]{y_2})$$

Since the denominators of these fractions are equal:

$$\frac{T}{m} = \frac{y_1\sqrt[3]{y_1} + y_2(\sqrt[3]{y_2} - \sqrt[3]{y_1}) + y_3(\sqrt[3]{y_3} - \sqrt[3]{y_2})}{y_3z_3}$$

But

$$y_1 = \frac{y_3z_3}{z_1} = by_3$$

and

$$y_2 = \frac{y_3z_3}{z_2} = ay_3$$

where

$$b = \frac{z_3}{z_1} = \frac{A}{A + B + C}$$

and

$$a = \frac{z_3}{z_2} = \frac{A}{A + B}$$

Substituting the values of y_1 and y_2 in the above equation gives:

$$T = \frac{m}{y_3\,z_3}\left(y_3^{\frac{4}{3}}b^{\frac{4}{3}} + y_3^{\frac{4}{3}}a^{\frac{4}{3}} - ab^{\frac{1}{3}}y_3^{\frac{4}{3}} + y_3^{\frac{4}{3}} - y_3^{\frac{4}{3}}a^{\frac{1}{3}}\right)$$

Simplifying this equation, we get:

$$T = \frac{my_3^{\frac{1}{3}}}{z_3}\left(b^{\frac{4}{3}} + a^{\frac{4}{3}} - ab^{\frac{1}{3}} + 1 - a^{\frac{1}{3}}\right)$$

The relation of a to b that will give a minimum value of T may be found by making $\dfrac{dT}{da} = 0$ and $\dfrac{dT}{db} = 0$, and solving the two resulting equations as follows:

$$\frac{dT}{da} = \frac{my_3^{\frac{1}{3}}}{z_3}\left(\frac{4}{3}a^{\frac{1}{3}} - b^{\frac{1}{3}} - \frac{1}{3a^{\frac{2}{3}}}\right) = 0$$

Since $\dfrac{my_3^{\frac{1}{3}}}{z_3}$ is not $= 0$

$$\frac{4}{3}a^{\frac{1}{3}} - b^{\frac{1}{3}} - \frac{1}{3a^{\frac{2}{3}}} = 0$$

$$\frac{dT}{db} = \frac{my_3^{\frac{1}{3}}}{z_3}\left(\frac{4}{3}b^{\frac{1}{3}} - \frac{a}{3b^{\frac{2}{3}}}\right) = 0$$

Hence

$$\frac{4}{3}b^{\frac{1}{3}} - \frac{a}{3b^{\frac{2}{3}}} = 0$$

$$4b = a$$

By substituting $a = 4b$ in the equation:

$$\frac{4}{3}a^{\frac{1}{3}} - b^{\frac{1}{3}} - \frac{1}{3a^{\frac{2}{3}}} = 0$$

$$a = 0.474 \text{ and } b = 0.1185$$

From the equation:

$$a = \frac{A}{A + B}$$

$$B = A\left(\frac{1 - a}{a}\right)$$

From the equation:

$$b = \frac{A}{A + B + C}$$

$$C = \frac{A}{b} - A - B = \frac{A}{b} - A - A\left(\frac{1 - a}{a}\right)$$

$$C = A\left(\frac{1}{b} - \frac{1}{a}\right)$$

By substituting $a = 0.474$ and $b = 0.1185$ in the preceding equation:

$$B = 1.11A \text{ and } C = 6.33A$$

Since the area varies as the square of the diameter, diameter of ram B is 1.05 × diameter of A; and the diameter of C is 2.52 × diameter A. Hence, for baling a material which obeys the law $y = kx^3$, the diameters of plungers A and B may be made equal and the diameter of C should be about 2.5 times that of A.

Time Required to Form Bale

The time required to run a press ram through its entire stroke when $y = kx^3$ and a three-plunger pump is used, having the diameters of the plungers in the ratio of 1, 1.05 and 2.52, may be found by substituting $a = 0.474$ and $b = 0.1185$ in the equation for total time T, which gives:

$$T = \frac{my_3^{\frac{1}{3}}}{z_3}\left(0.1185^{\frac{4}{3}} + 0.474^{\frac{4}{3}} - 0.474 \times 0.1185^{\frac{1}{3}} + 1 - 0.474^{\frac{1}{3}}\right)$$

$$= \frac{0.42my_3^{\frac{1}{3}}}{z_3} = \frac{0.42mp^{\frac{1}{3}}}{A} = \frac{0.42M}{vA}\sqrt[3]{\frac{p}{k}} = \frac{0.42Mx}{vA}$$

General Case for Three-plunger Pump

The diameters of plungers for pumps designed to operate any baling machine, regardless of the material to be baled, should be based on the assumption that $y = kx^3$. This value may be considered an average for the materials commonly operated upon; but if it is definitely known that a pump is to supply water to a press for compressing any given material, such as tankage, apples, grapes, olives, hay, tin cans, etc., the exact relation between pressure and travel may be easily determined by experiment. The pressure per square inch of the liquid in the cylinder is read from a gage for a number of positions of the ram, and these data plotted on log-log paper or the values of n and k are determined by substituting values of x and y in the equation $y = kx^n$, which may be used for practically any material.

By using $y = kx^n$ instead of $y = kx^3$, it is found for a three-plunger pump that:

$$a = (n+1)b$$

and

$$b = \frac{1}{(n+1)^2 - n(n+1)\dfrac{n-1}{n}}$$

From these equations, values of a and b and the areas and diameters for given values of n are shown in Table 1.

TABLE 1. RATIOS OF PLUNGER DIAMETERS FOR THREE-PLUNGER PUMP

n	b	a	Area of B / Area of A	Area of C / Area of A	Diam. B / Diam. A	Diam. C / Diam. A
1	0.333	2b = 0.666	0.50	1.50	0.70	1.22
2	0.179	3b = 0.549	0.84	3.69	0.92	1.92
3	0.118	4b = 0.474	1.11	6.33	1.05	2.52
4	0.085	5b = 0.429	1.33	9.33	1.15	3.05
5	0.067	6b = 0.406	1.46	12.29	1.21	3.51

Machinery

General Case for Two-Plunger Pump

In the case of a pump having two plungers with areas A and B, it may be shown that:

$$a = \frac{A}{A+B} = \frac{1}{n+1}$$

from which

$$B = An$$

The relative values of A and B and their corresponding diameters are shown in Table 2 for different values of n.

TABLE 2. RATIOS OF PLUNGER DIAMETERS FOR TWO-PLUNGER PUMP

n	Area of B / Area of A	Diam. B / Diam. A
1	1	1.00
2	2	1.41
3	3	1.73
4	4	2.00
5	5	2.24

Machinery

Determination of "Knock-out" Pressures

The method of finding the "knock-out" pressure is illustrated by the following example: A three-plunger pump having a piston velocity of 50 feet per minute, diameters of plungers 1.5 inch, 1.5625 inch, and 3.75 inches, gives a maximum pressure of 1500 pounds per square inch. The efficiency of the pump is 70 per cent.

The maximum horsepower required is:

$$\text{H.P.} = \frac{1500 \times 50 \times 1.76}{33{,}000 \times 0.7} = 5.72$$

This is found by using the maximum pressure and the area of the plunger giving that pressure. The maximum horsepower is reached when the product of the pressure into the area is equal to:

$$1500 \times 1.76 = 2640$$

The area of all three plungers is $1.76 + 1.91 + 11.04 = 14.71$ square inches, which gives $\frac{2640}{14.71} = 180$ pounds per square inch for the first "knock-out" pressure. The sum of the areas of the second and third rams is $1.76 + 11.04 = 12.80$ square inches, and the second "knock-out" pressure is $\frac{2640}{12.80} = 206$ pounds per square inch.

These pressures are lower than those generally found on pumps for baling presses; but in view of the fact that fibrous materials, such as cotton, approximately compress according to the equation $y = kx^3$, and the ram is at $\sqrt[3]{\frac{180}{1500}} = 0.49$ and $\sqrt[3]{\frac{206}{1500}} = 0.52$ of its total run when these pressures are attained, the advantage of the low "knock-out" pressures is readily appreciated.

* * *

IGNORANCE IN STARTING A MANUFACTURING BUSINESS

A large percentage of business failures are due to the lack of knowledge of the business entered and the equipment and organization required. Men engage in retail selling with little or no business experience. They buy goods unwisely, acquire ill-balanced stocks, and finally fail with a lot of bad accounts which can never be collected. The manufacturing business is no exception to the rule, and many heedless, ill-advised ventures are often met with in manufacturing. It is stated by a machine tool salesman of broad experience in selling new machinery and dealing in second-hand tools that a large percentage of the men who start small manufacturing enterprises know practically nothing of manufacturing principles and are almost totally ignorant of the equipment required to produce their products efficiently. They buy lathes, planers, drilling machines, milling machines, and other standard machines with little discrimination and set them up in orderly rows in their new quarters. Power is turned on and the wheels start in motion, but machinery running does not necessarily result in turning out marketable carbureters, gas engines, egg beaters or anything else. The important elements of directive skill and sales organization are too often lacking. After struggling along miserably for a few months, a lot of machine tools, somewhat the worse for wear, are offered to second-hand dealers.

* * *

ENGINEERING COUNCIL

The first meeting of the Engineering Council was held in the Engineers' Bldg., New York City, June 27. This body is a department of the United Engineering Society and has recently come into being as a medium of cooperation between the four national engineering societies. The function of the council is to speak authoritatively for all member societies on all public questions of a common interest or concern to engineers. It is composed of twenty-four members, five being appointed from each of the four founder societies and four by the United Engineering Society; the founder societies are the American Society of Civil Engineers, the American Institute of Mining Engineers, the American Society of Mechanical Engineers, and the American Institute of Electrical Engineers. At the organization meeting, Dr. I. N. Hollis was elected president of the council; H. W. Buck and George F. Swain, vice-presidents; and Calvert Townley, secretary. Ways and means were discussed by which the societies through the council might be of use to the national government. A resolution was adopted instructing the executive committee to cooperate with the government in procuring the services of engineers, and a committee was appointed to consider the best means of utilizing the inventive ability of members of the founder societies.

Factory Transportation-2

by Edward K. Hammond[1]

MOTOR-DRIVEN trucks, provided with their own power plant in the form of an electric storage battery and motor, are now being used in many industrial plants in the United States. Trucks of this type naturally cost considerably more than any of the trucks which are driven by manual labor, and the only justification for investing in equipment where the first cost is higher is if conditions of operation are such that a greater amount of service might be obtained from motor-driven trucks. It is difficult to make statements to cover general conditions, but in the present case it may be stated that the particular field of usefulness of motor-driven trucks is where the length of haul is sufficiently great so that a material saving of time and labor may be obtained through the increased speed. Running on hard level surfaces, the speed of these trucks will be about seven miles an hour, and the average truck has a capacity for running about twenty-five miles on a single battery charge.

The driver stands erect on a platform at the end of the truck, with his hands on the controller and steering levers, respectively, and one foot on the brake pedal. Simplicity of operation does away with the necessity of hiring high-priced operators for these trucks. Where motor-driven trucks can be kept busy, the General Vehicle Co. of Long Island City, N. Y., claims that with hauls ranging from 200 to 800 feet each truck will take the place of from four to six men. An idea of the rate at which these trucks operate will be gathered from the fact that a time study made in unloading bags of cement at a New York pier showed that it took thirty minutes to unload thirty-eight bags of cement and transport them a distance of 500 feet, where four men were employed operating hand trucks. With an electric truck, two men handled seventy similar bags in seventeen minutes and carried them 750 feet instead of 500 feet. It is not claimed that any such saving may be expected in all cases. There are many classes of work where better results will be obtained with hand trucks; but for those classes of service for which motor-driven trucks are adapted, they give highly satisfactory results.

A manufacturer who contemplates the installation of motor-driven trucks will naturally ask himself, "What will it cost to operate such equipment?" For the benefit of such men it may be stated that the average cost of running an electric truck and the necessary charging equipment—including maintenance, interest, depreciation, taxes, insurance and charging current—is $2.50 per working day, exclusive of operator's wages. A single charge of the battery during the preceding

[1] Associate Editor of MACHINERY.

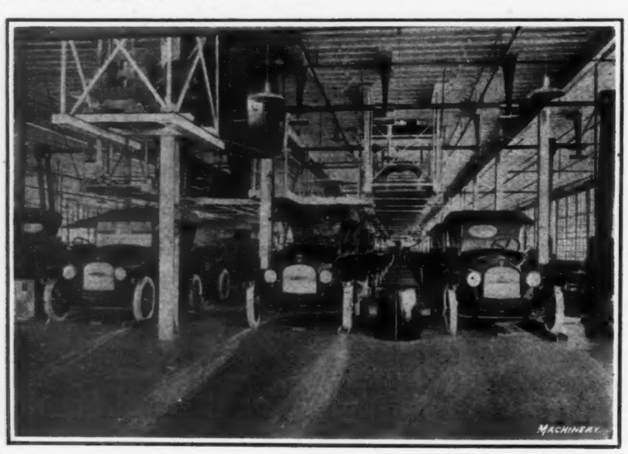


Fig. 55. Progressive assembly of automobiles has been developed to a high degree by engineers of the Willys-Overland Co. Four assembling tracks are provided in the factory, down which cars are run, and conveyors running at right angles to these tracks carry all the different parts to the assemblers. This system has been brought to a high degree of perfection and work is handled very rapidly

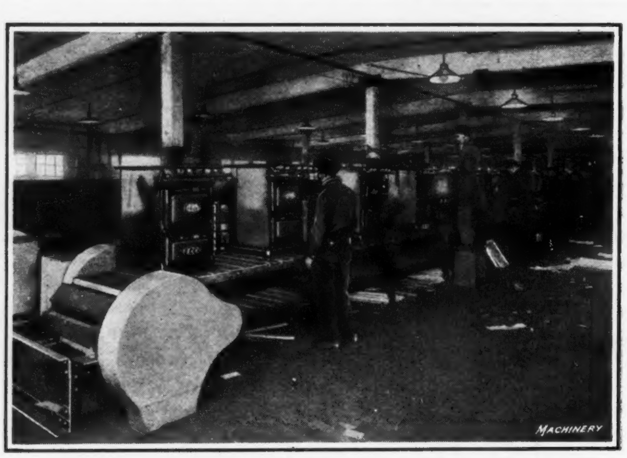


Fig. 56. The benefits secured by progressive methods of assembling in automobile factories have been so marked that this method is now finding application in other industries. The Detroit Stove Works is making use of a conveyor system installed in its plant by the Palmer-Bee Co. of Detroit, Mich., for use in the progressive assembly of gas ranges

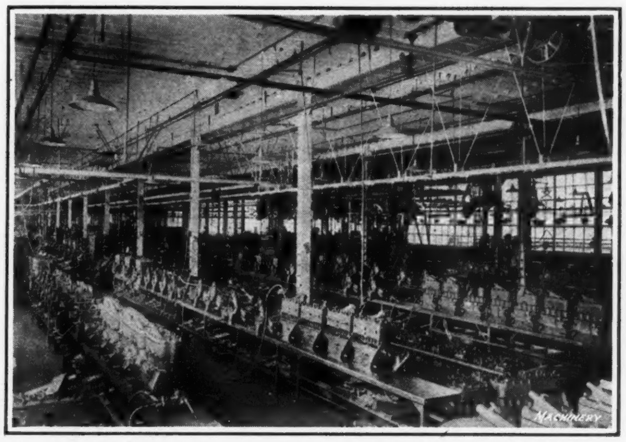


Fig. 57. Overhead conveyors are used in the motor assembling department of the Willys-Overland Co., Toledo, Ohio, for carrying the larger parts of the motors to the assembling benches. Small parts are held in New Britain tote boxes underneath the benches, where they are within convenient reach of the operator

Fig. 58. In the Ford Motor Co.'s plant every possible saving is effected in production. In assembling motors, as fast as one man finishes his task he pushes the motor along to his companion and receives a new motor from the man on the other side. This is another example of the progressive method of assembling

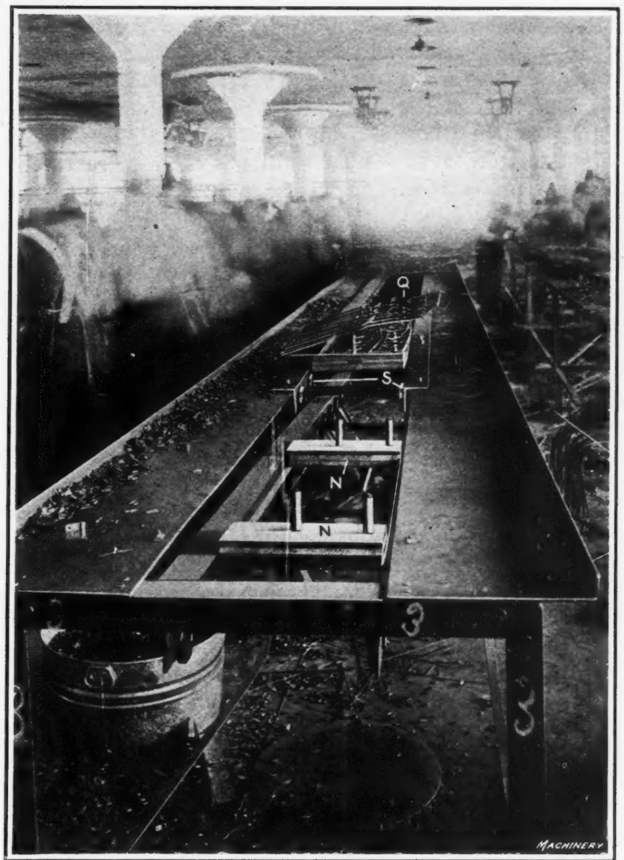


Fig. 59. Progressive methods of assembling are used in manufacturing automobile cushion springs. In the Detroit Wire Spring Co.'s factory, the Palmer-Bee Co. has installed equipment for handling this work. The spring frames are placed on small trucks, on which they are carried along the bench from man to man, and the various parts of the spring are put together

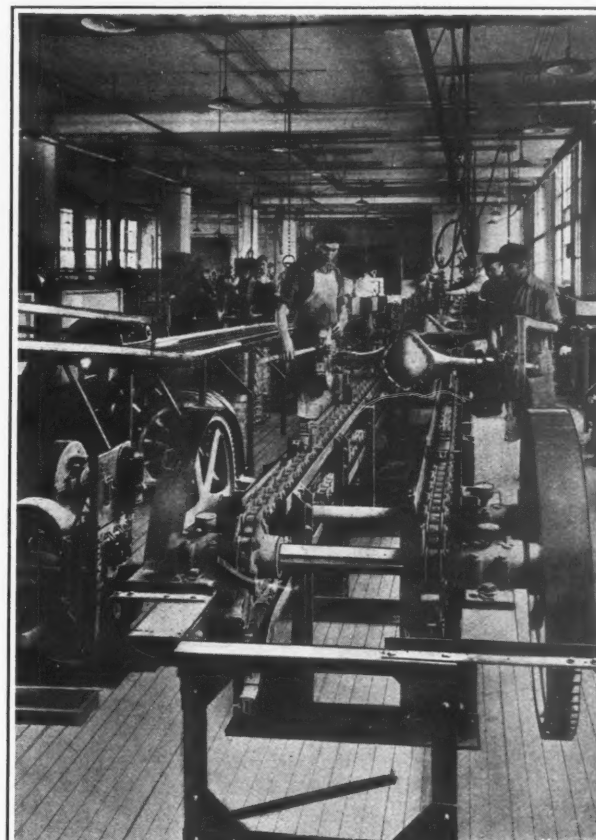


Fig. 60. The Palmer-Bee Co. of Detroit, Mich., makes a specialty of designing and installing time- and labor-saving equipments for handling material in course of manufacture. This illustration shows an outfit installed by this company for assembling automobile transmissions. Two strands of endless chain carry brackets which support the work at each end

Fig. 61. In this case the magnetic generator unit of the motor is carried on an endless belt conveyor, and men with power-driven wrenches are screwing up the nuts. Attention is called to the large number of men at work; this is typical of the intensive production methods in the Ford Motor Co.'s shops

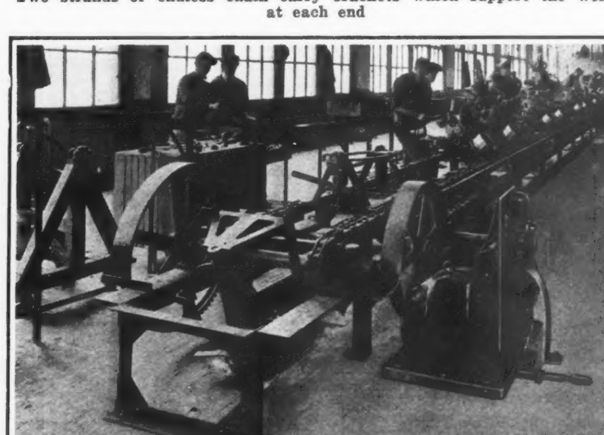


Fig. 62. Formerly the Packard Motor Car Co. assembled clutch units on stands that were distributed over the floor of the clutch assembling department. The Palmer-Bee Co. suggested that the progressive method of assembly be employed in handling them, so a conveyor system was installed, which carries stands similar to those formerly employed

Fig. 63. Where it is necessary to transfer work from an upper floor in a building to an upper floor in another building, much time is lost in taking the work down and up in elevators in the ordinary way. Sometimes it is possible to have a conveyor carry the work right across from one building to the next, as here shown

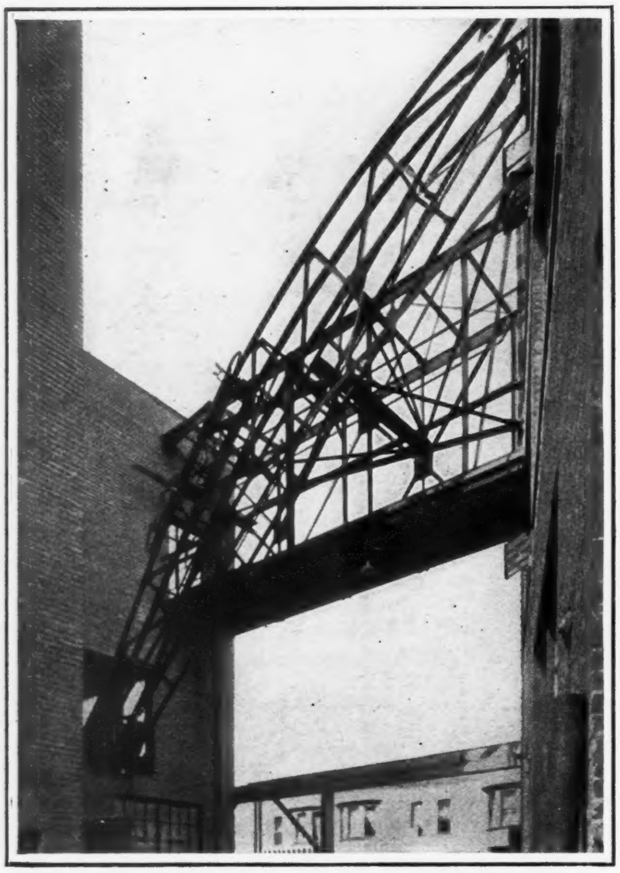


Fig. 64. In the Studebaker Corporation's factory in Detroit it is necessary to transfer automobile frames from one building to a floor two stories higher up in an adjacent building. For this purpose a conveyor system was installed by the Palmer-Bee Co. It consists of a structural steel frame with rails, over which the automobile frames are pulled by an endless chain conveyor

Fig. 65. Factories engaged in building heavy machinery, structural iron work, etc., find it necessary to have cranes for loading finished product onto cars. This illustration shows the work of loading a kerosene tractor onto a flat car. The crane was built by the Northern Engineering Works of Detroit, Mich.

night is sufficient to run the truck with its full load of two tons for 90 to 100 round trips of 1000 feet. Batteries may be charged while in the truck or a complete change of batteries may be made in five minutes. A laborer of average intelligence can be taught to drive one of these trucks in a few hours, and automatic safety control features make it practically impossible to damage the load or for the operator to be injured.

One point that stands out in favor of the use of motor-driven trucks is that when a man can ride, little difficulty is experienced in keeping him at work; but when he is required to pull a heavy truck, which is a tiresome job, he is not likely to stay long. Hence the motor-driven truck may be said to constitute a means of saving employers the expense of breaking in new help. In conclusion, it may be stated that motor-driven trucks may be furnished with flanged wheels for operation on rails, or with rubber tired wheels to travel on the floor. Signal systems of various kinds may be used—such as electric lamps or flags—to show when aisles are clear for the passage of trucks, or when one truck is likely to meet another before reaching the opposite end of an aisle. Electric trucks are built in many designs to meet the requirements of different classes of work. Elevating trucks are made for use in connection with platforms, boxes, etc., and plain trucks are made for carrying loads directly. In addition, there are the so-called tractors designed for pulling one or more cars on which the load is piled.

Demountable Body Trucks

Motor trucks may be employed to advantage in many shops for carrying shipments from a factory to the main line of a railway, shipping dock, etc., or for making quick deliveries within twenty or thirty miles of the plant. Where the tonnage to be handled is large, it may be desirable to use one or more trailers in connection with a truck in order to increase its carrying capacity. A good grade of motor truck is quite costly, and this makes it necessary for the firm employing one or more of these trucks to take advantage of every opportunity to secure the greatest possible return on its investment. One way of greatly increasing the amount of service obtained from motor trucks is to use what are known as "detachable" bodies. Two or more of these bodies may be used in connection with each truck, so that when a truck comes in loaded the removable body can be lifted off and carried away by trolley hoists, after which an empty body is substituted so that it may haul away a new load or go out after a fresh load, as the case may be. While the truck is away from the plant the load brought in on the previous trip—which has been removed with the detachable body—is taken to its destination by the trolley hoist, and the empty body is brought back ready to be exchanged for a full body when the truck returns with its next load. This method is said to be the means of increasing the capacity of motor trucks from 50 to 100 per cent when used under conditions that enable maximum efficiency to be attained. In the case of very heavy loads, the detachable body may be furnished with nests so that the load may be divided to bring it within range of the trolley hoists. In some cases the bodies are mounted on auxiliary casters or wheels upon which they may be moved.

Progressive Machining Operations

Where machining operations to be performed on a given part are of such a nature that a battery of planers, milling machines, drill presses, boring machines, etc., is required to finish a piece, it is of the utmost importance to have these machines so grouped that the work passes continuously from machine to machine without delays. In many well organized factories the equipment has been so arranged that conveyors, trucks or some other form of device can be used to carry the work from machine to machine with the least amount of time and labor.

An example of this kind is seen in the milling operations on aluminum crank-cases in the plant of the Buick Motor Co., Flint, Mich. The first four milling operations are performed on Ingersoll planer-type milling machines, which provide for handling five upper and five lower halves of the crank-cases at

a time. In operation, the table is run forward under the cross-rail, and castings placed ready on the floor are dropped into position in the milling machine fixtures without any attempt to tighten the clamps on the fixtures. Then as the table starts to feed back, the operator starts with the fixtures nearest the cross-rail and tightens up all bolts so that the work is secured for machining. After all the work has been secured, he goes to a position back of the cross-rail and starts taking out the milled cases, which are swung over onto gravity carriers and rolled down to a position ready to go on the next Ingersoll milling machine. In this connection it is important to note that the gravity carriers are made the same height as the milling machine tables so that the work can be transferred from the carrier to the table and *vice versa* with the minimum effort.

A more highly developed method of progressive machining consists of having tracks laid between different machines on which trucks run that support jigs and fixtures for carrying the work. Fig. 38, in the first installment, shows a view in the plant of the Packard Motor Car Co., Detroit, Mich., where crank-cases are being drilled. There are 200 holes to be drilled in these cases and the complete drilling operation is finished in forty-two minutes; the actual drilling time is thirty-eight and one-half minutes and three and one-half minutes are allowed for setting up and removing work from the jig. The machine tool equipment consists of seven Baush multiple-spindle drilling machines with various numbers of spindles and different types of heads, and one radial drilling machine. The jigs are arranged so that they can be pivoted to bring different surfaces of the work into the operating position. Index-pins enter hardened steel bushings in the jigs, locating them accurately for each successive operation, and clamps are provided which secure the jig trucks in place on the tracks. Handled in this way, a high rate of production may be obtained, because the workman is relieved of all physical strain in lifting work on and off machines, it being merely required for him to set the work up in the jig at the beginning of the row and remove it when the job is finished. One workman follows a single casting right down the line, performing all the machining operations required on it.

For boring, milling and other operations where the fixtures are of such a type that it would not be feasible to use a single fixture for a number of operations, a somewhat similar idea may be employed. Instead of having the work and fixture taken from machine to machine on tracks, a roller type conveyor is run parallel to the line of machines, with switches branching off to individual machines, as was illustrated in Figs. 44 and 45 in the July installment. With an equipment of this kind the operator can push a heavy casting along on the conveyor and run it in on the switch to a given machine. The conveyor and the machine table are the same height, so that the operator merely swings the work over from the conveyor and puts it in position in the fixture for machining. When the operation has been completed, the casting is put back on the switch and run up to the main line, upon which it is carried to the switch leading to the next machine. Where this method has been adopted it has been found the means of saving a great deal of time in the performance of machining operations.

Laying Out Gravity Carriers

As the name implies, the pitch of a gravity carrier is relied upon to enable the force of gravity to run the load along the conveyor without the application of power from an external source. In designing this type of equipment it is the practice of the Mathews Gravity Carrier Co., Elwood City, Pa., to make the pitch of conveyors from 2 to 8 per cent, but most of the conveyor systems installed by this company have a pitch of 4 per cent. In the construction of conveyor systems of this type, there is a good deal of variation in the lay-out, according to the nature of the work to be carried. Packages with smooth, flat bottoms may be run on these carriers without guard rails, but where the load is irregular in shape some form of guard rail is necessary.

Various expedients are adopted to keep the load running on these conveyors. The most obvious way is to place a guard

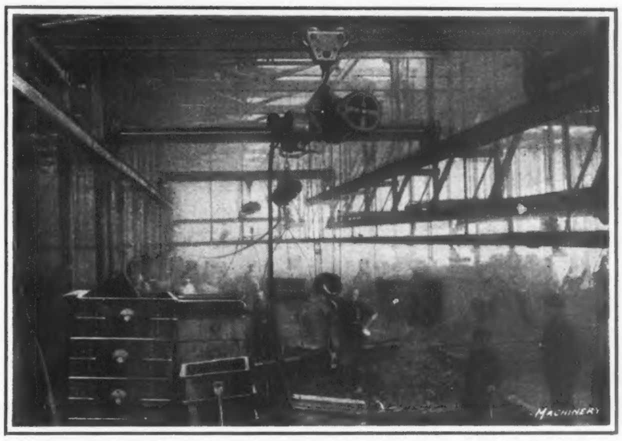


Fig. 66. In foundries where moderate loads are to be handled at fairly frequent intervals, it is convenient to use a crane in which the trolley and bridge are operated by hand, and the hoist is driven by power. Cranes of this type are shown here, equipped with "Imperial" pneumatic motor hoists built by the Ingersoll-Rand Co., New York City

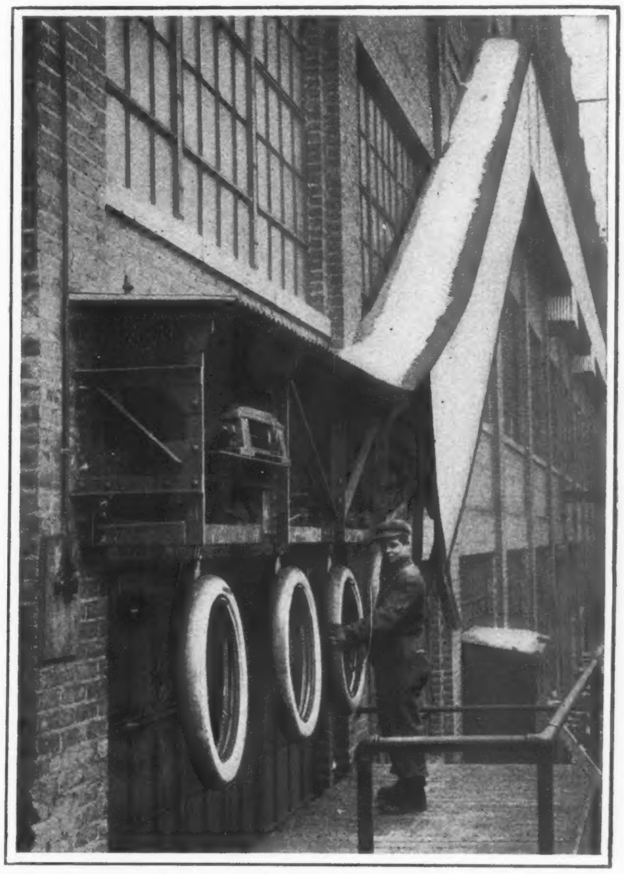


Fig. 67. Where there is considerable congestion in a shop, it may be desirable to hang conveyor systems and similar equipment on the outside of buildings. A case in point is seen in the accompanying illustration, which shows a view of a conveyor system installed in the Studebaker Corporation factory for handling tires, wheels and hubs. The conveyor is an endless chain with hooks for carrying the work

Fig. 68. One 200-ton and one 20-ton electric traveling crane with a span of 75 feet, 6 inches are here shown in use in a railroad shop. These cranes were built by the Niles-Bement-Pond Co., New York City. The weight of the suspended engine is 270 tons. Attention is called to the method of lifting the locomotive from four corners

Fig. 69. This illustration shows a bin at the side of the railroad at the Ford Motor Co.'s plant in Detroit for storing coal, coke, limestone, scrap metal, etc. The Shaw Electric Crane Co., Muskegon, Mich., installed a gantry crane equipped with a grab bucket for handling this material

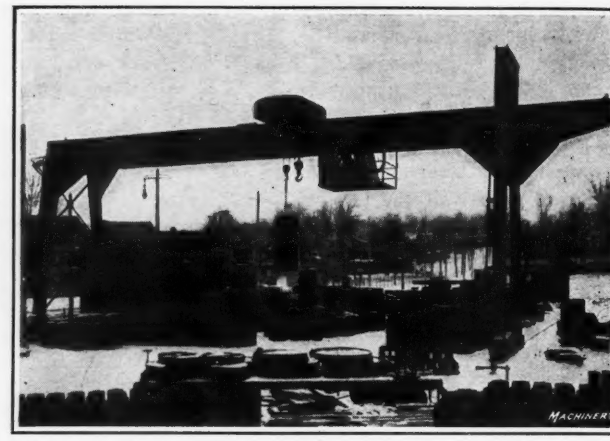


Fig. 70. Gantry cranes are generally used where the amount of service is not great enough to warrant the construction of an overhead runway for a traveling crane. Gantry cranes are more expensive to operate, however, and this may offset the lower first cost. The crane here shown was built by the Northern Engineering Works, Detroit, Mich.

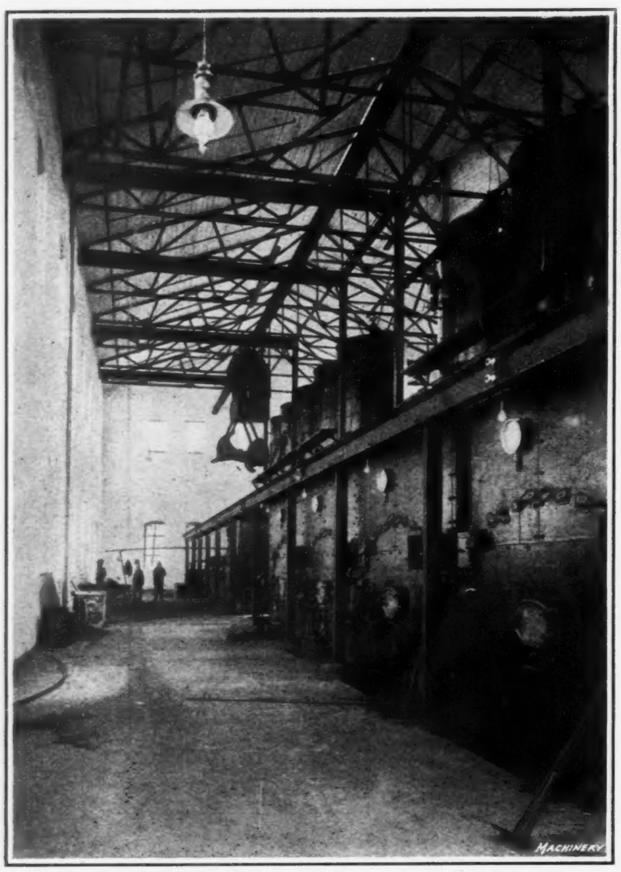


Fig. 71. In large power plants it will often be found necessary to provide special equipment for the handling of fuel, as manual labor is too slow. This illustration shows a monorail bucket hoist built by the Northern Engineering Works for charging coal into boiler hopper storage tanks in a large power plant

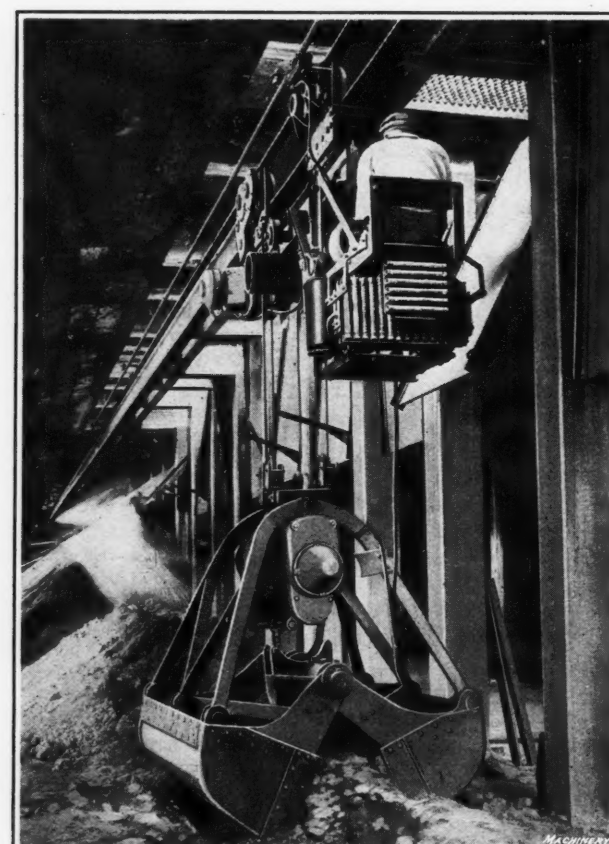


Fig. 72. In foundries where there is a lot of sand, coke and limestone to be handled, it will sometimes be found advantageous to employ a grab bucket. This illustration shows a trolley hoist built by the Sprague Electric Works of New York City, equipped with a grab bucket for use in a foundry. Such an outfit operates at a high rate of efficiency

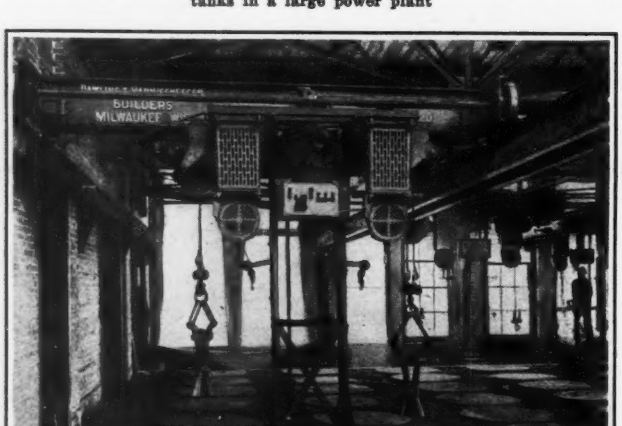


Fig. 73. Crane builders are often called upon to construct special equipments to meet the requirements of various industries. The illustration shows cranes built by the Pawling & Harnischfeger Co., Milwaukee, Wis., especially for handling work in the annealing shop of a car wheel foundry

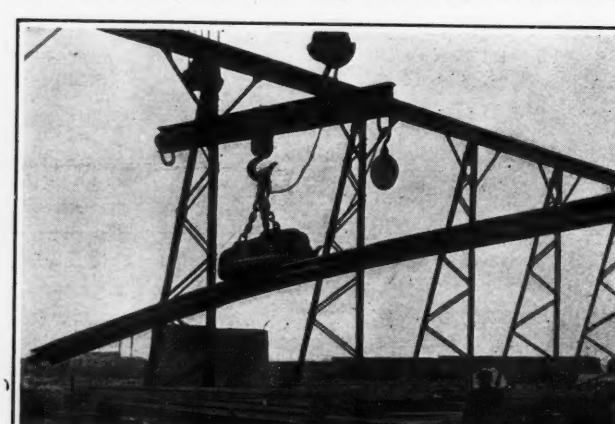


Fig. 74. Lifting magnets are used for handling various iron and steel products. This illustration shows an electromagnet built by the Cutler-Hammer Clutch Co., Milwaukee, Wis., lifting long steel bars. A special arrangement of a beam and two hoists prevents the magnet and its load from rotating

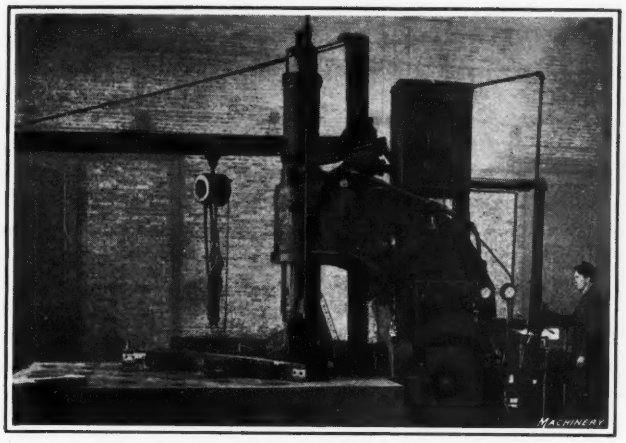


Fig. 75. There are many pieces of work that are a little difficult for one man to handle alone, and if he attempts to do so, he is likely to waste a considerable amount of time in setting up. This illustration shows the use of a jib crane equipped with a Yale & Towne chain block for handling such work

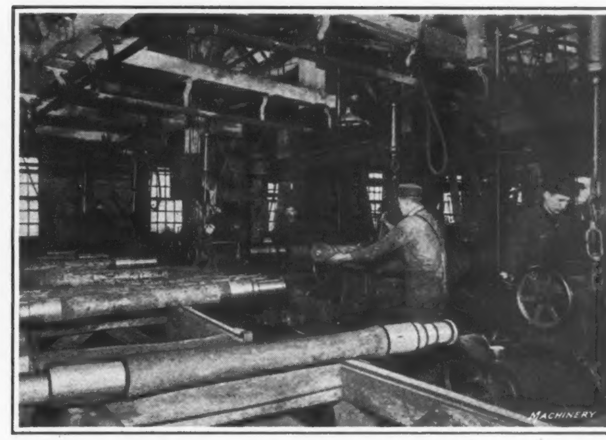


Fig. 76. Car axles are too heavy to be handled by one man. This illustration shows a view in the Griffin Wheel Co.'s plant in Chicago, where each axle lathe is equipped with an air cylinder hoist for setting up work and removing it. Turned axles are rolled on rails to the hydraulic wheel press

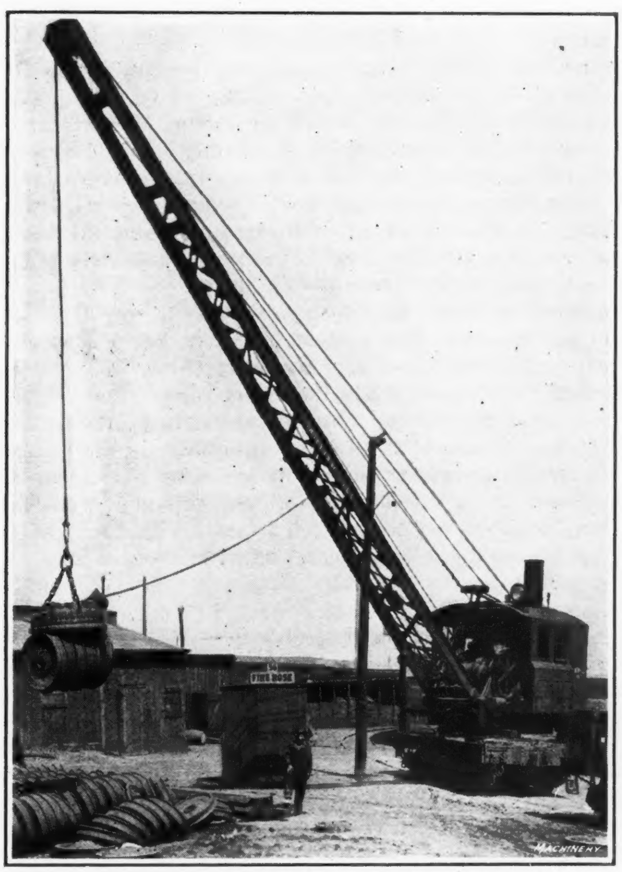


Fig. 77. A locomotive crane is useful for handling materials in factory yards where there is a lot of space to be covered. This equipment may be employed as a switch engine when there is no lifting to be done. The illustration shows a locomotive crane and lifting magnet used by the Griffin Wheel Co., Chicago, Ill., for handling car wheels

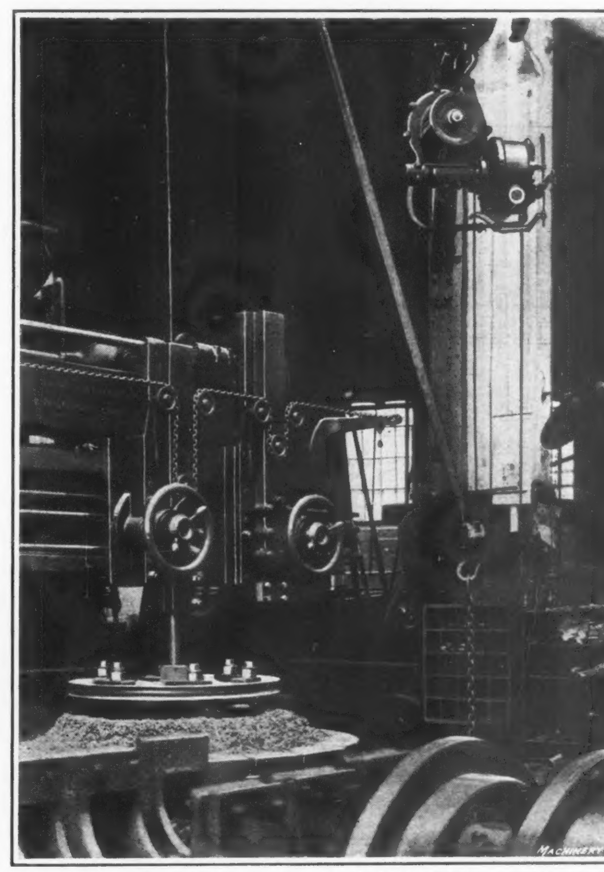


Fig. 78. An "Imperial" pneumatic motor hoist built by Ingersoll Rand Co., New York City, is used to assist the operator in setting up heavy work on a turret lathe and to remove completed work from machine. Having an individual hoist for a machine avoids loss of time by the operator and machine in waiting for assistance

Fig. 79. To facilitate pouring metal into molds in the Ford Motor Co.'s foundry, molds are brought in on a conveyor and transferred to a carousel on which each mold is supported by a pendulum. This swinging support eliminates vibration and prevents molds breaking. Molds are carried away by a second conveyor

Fig. 80. One jib crane can often be arranged to serve a number of machines, molds, etc. In the Griffin Wheel Co.'s foundry, car wheel molds are arranged in a circle, with a jib crane at the center, equipped with an air hoist built by the Curtis Pneumatic Machinery Co., St. Louis, Mo.

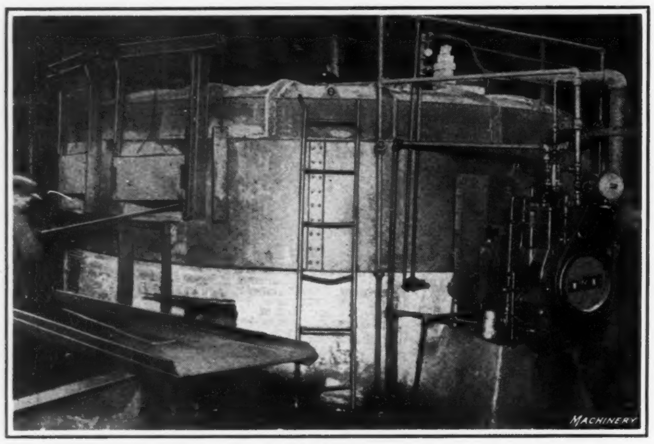


Fig. 81. In the Timken-Detroit Axle Co.'s plant special furnaces with a rotary hearth are maintained at such a temperature that forgings are raised to the proper temperature for heat-treatment by one revolution. These furnaces save space and keep operator busy

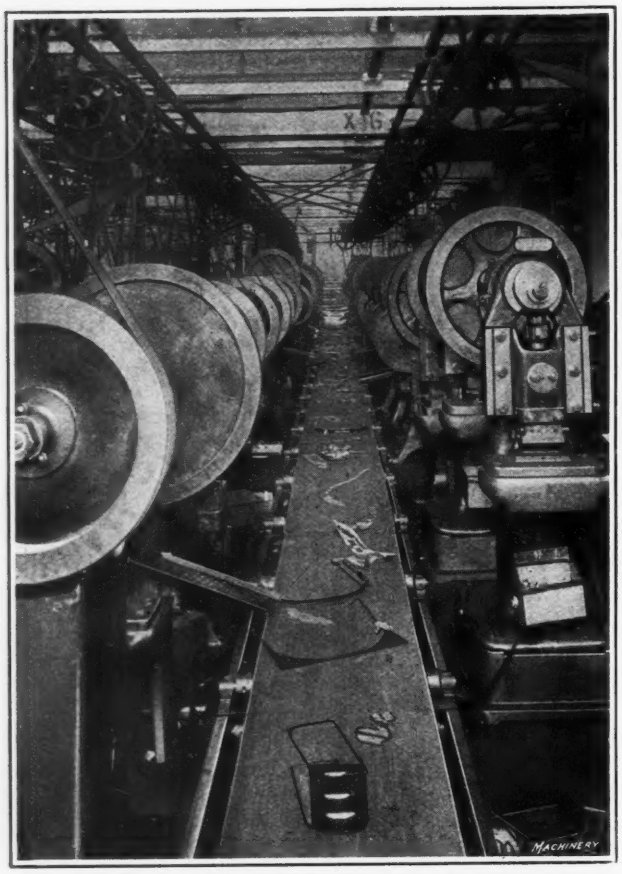


Fig. 82. In the Ford Motor Co.'s plant, use is made of belt conveyors for carrying away the product of power presses. Chutes are provided by means of which the product is transferred from the machines to the belt conveyor which carries it away. This is the means of saving the time ordinarily required for removing the product in trucks

Fig. 83. An elevator raises the work to the upper floor in the Willys-Overland Co.'s plant. This equipment, installed by the Link-Belt Co., Chicago, Ill., consists of an apron-type conveyor with cleats to prevent the work from slipping back. A chute at the left returns the tote boxes to the lower floor

rail at each side so that it is impossible for the load to run off. A simple method and one that is highly satisfactory where the packages or parts to be carried are of fairly regular shape, is to have a small flange at both ends of each roller. This flange rotates with the roller so that there is no loss of efficiency through the retarding action of a fixed guard rail, and still it is effective in preventing work from running off. A still simpler method and one that is effective in cases where the work has a smooth surface to run on is to make the conveyor with two sets of rollers. These rollers are arranged in pairs, with the rollers of each pair inclined at a slight angle, so that the two rollers have a form somewhat similar to the letter V (the angle is much less acute) with the apex pointing in the opposite direction to that in which the load is to travel. The effect of this inclined double roller construction is to keep the load on the conveyor, the tendency of each of the inclined rollers being to force the load toward the center. For handling pig iron and other irregular shaped pieces of this kind, the only way to be sure of keeping the load on the conveyor is to use a guard rail at each side.

Use of Revolvator

A machine known as a "revolvator" is built by the New York Revolving Portable Elevator Co., Jersey City, N. J. This is a portable elevator mounted on a revolving base so that the elevator platform may be faced in any direction to receive or discharge a load, as the case may be; ball bearings in the revolving base enable the elevator to be easily swiveled when carrying its maximum load. This type of equipment is used for a variety of different classes of service in industrial plants, but a typical case is where it is desired to raise or lower a load and turn the elevator in the direction in which the load is to be deposited. For instance, suppose that a stock-room is arranged with aisles running over to the wall and the necessity for economizing in the use of space makes it necessary to stack material up almost to the ceiling. Here the revolvator may be used to excellent advantage, as the material is brought on elevating trucks or in any other convenient way and deposited on the platform of the revolvator. The load is then raised to the desired height and the platform turned so that the load may be run off at either side of the aisle onto the top of the material already stacked.

A similar use is where sheet metal and other material is being stacked in racks; the revolvator carries the load down an aisle, and when it reaches its destination, the platform is raised and turned through one-quarter revolution to allow the load to be slid off onto the racks. Another similar example is where heavy dies for use on power hammers and presses are kept in storage racks. These dies are so heavy that they are hard to handle, and work of this kind can be done conveniently by pulling them out on the platform of the portable elevator, which is then lowered to a convenient height. The entire elevator then serves as a truck on which the die is pulled to the machine on which it is to be used. Here the platform of the elevator is adjusted to bring it to the same height as the bed of the machine, so that the die may be easily slid off the elevator platform, into place on the machine.

Portable elevators of this type are made in two standard sizes, with capacities for handling loads up to 800 pounds and 1800 pounds, respectively. By the use of special bracing, elevators have been made for carrying loads up to 2500 pounds. Elevators up to and including seven feet in height are made with the structure in a single piece; but when the height exceeds seven feet, the structure is hinged so that no difficulty is experienced in pulling the elevator through doors from one department to another. The platform is raised by hand by means of gearing turned by a crank. When it is necessary to lower the load, the first step is to take the crank off the squared end of the shaft; the crank is then fitted onto a lowering brake, and until this is done the platform cannot be lowered. By means of the crank, the brake may be adjusted to any required degree while lowering the load.

In revolving the entire structure of the elevator, the first step is to withdraw a locking pin that holds the elevator in one of four 90-degree positions around the complete circle.

When this pin has been withdrawn, the elevator is usually turned by hand, taking hold of the elevating crank. Some users of portable elevators employ them as a means of transporting material from one department to another located on a higher or lower floor. This is done by having a trap door in the upper floor through which the elevator platform may be raised or lowered with the material. Such an arrangement would only be recommended where departments are not laid out in the normal way; ordinarily, where there is a demand for equipment to transfer work from one floor to another, some permanent form of elevator would be more desirable.

Portable Scoop Conveyor

For handling coal of all grades, coke, ashes, crushed stone, sand, gravel, small castings and a variety of other similar material, the Portable Machinery Co., Inc., Passaic, N. J., is now building the portable scoop conveyor shown in Fig. 87. This equipment consists of a scoop which can be buried in the material to be handled, and an endless traveling belt which carries the material up and discharges it into a wagon, chute or other receiver. The conveyor belt has transverse cleats to prevent the material from slipping back down the incline. One man and this scoop conveyor can handle coal or similar material at the rate of one ton in one and one-half minute, *i. e.*, forty tons per hour. This outfit can be equipped with an electric motor or gasoline engine for driving the belt, and as it weighs only 900 pounds and is mounted on wheels, it may be easily taken to any desired place. The amount of power required to drive the conveyor is 1½ horsepower.

A special machine is used at the plant of the Boss Nut Co., Chicago, Ill., to charge tumbling barrels with blank punched nuts, take these nuts from the tumbling barrels, and distribute them in bins located convenient to the tapping machines. This apparatus consists of a modified form of the standard tiering machine built by the Economy Engineering Co., Chicago, Ill. It has a cantilever type of platform, open on three sides. The main uprights extend into a pit about three and a half feet below the floor level.

The platform consists of two arms, on which run the flanged wheels of a small transfer car; the latter, in turn, carries a pair of rails at right angles to its direction of movement. On these rails is placed a small hopper-bottomed car with a capacity of about 2000 pounds of punched nuts. The pit extends under the tumbler, and at the bottom are rails to allow the transfer car with the hopper car to be moved to a position directly under the tumbler. A steel frame is also provided above the tumbler so that the transfer car can be moved over the tumbling barrel. At one side of the machine is a row of bins, over the tops of which runs a track on which the hopper car moves.

To charge the tumbler, the platform of the machine, with the transfer and hopper car, is lowered to the bottom of the pit, bringing the top of the hopper car on a level with the floor. The punched nuts are then dumped into it from the kegs in which they have been deposited at the punchers. The platform with its load is then raised to the top position and the transfer car with the loaded hopper car moved to a position over the tumbling barrel, where the gates at the bottom of the hopper are opened and the nuts drop into the tumbling barrel. Here they are tumbled with sawdust until polished. The tumbling barrel is provided with perforations and a wooden tray is placed under it while the tumbling operation is being carried on, so that the sawdust gradually works out and is entirely eliminated by the time the polishing is completed. To empty the tumbling barrel, the transfer car is again moved into the elevator platform and lowered to the position in the bottom of the pit, where it is moved under the tumbler and the polished nuts are deposited in the hopper car. It is then returned to the elevator and hoisted to the level of the track over the bins and then pushed by hand to the proper bin, where the load is deposited by opening the gates in the bottom of the hopper.

The elevator is operated by means of a three-horsepower General Electric motor, through silent chain drive to a series of machine-cut spur gears connected to a drum upon which the steel hoisting cable winds. Automatic top and bottom

Fig. 84. A jib crane must be provided with support for the outboard end of the beam. This is often done by means of tie-rods. In this case the ceiling is too low to permit of this construction, so the outer end of the beam is furnished with a trolley which runs on a semi-circular rail

Fig. 85. In automobile tire factories there are a lot of heavy molds to be handled, and some means of assisting the operators must be provided. This view shows a chain hoist built by the Wright Mfg. Co., Lisbon, Ohio, in use in the Knight Tire & Rubber Co.'s plant. The molds are being placed in a vulcanizer

Fig. 86. Combinations of equipment are often necessary. This view in the Detroit Wire Spring Co.'s shops shows a conveyor and elevator. Assembled cushion springs are carried to the crating department, where they are packed, and the elevator carries crates to shipping department

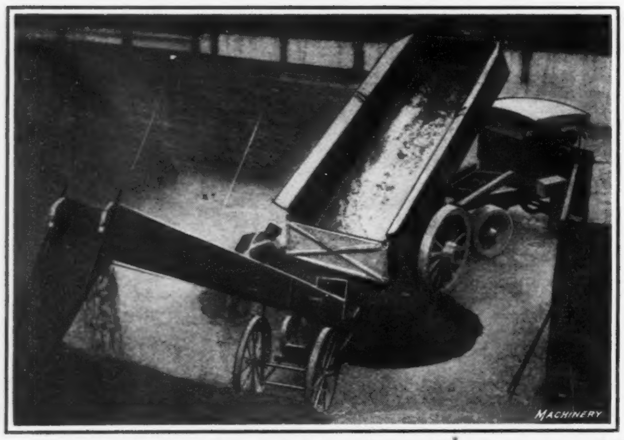


Fig. 87. For handling loose material, such as coal, sand, etc., a scoop conveyor is made by the Portable Machinery Co., Inc., Passaic, N. J. This consists of a scoop and a power-driven belt conveyor that carries the material up an incline and delivers it into a chute

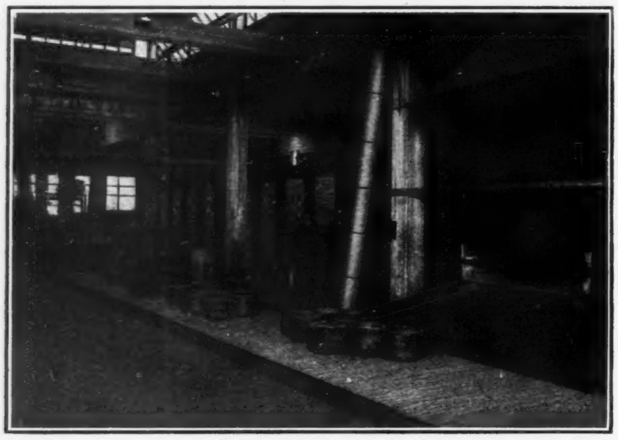


Fig. 88. There is often lack of system in handling metal goods which are to be heat-treated; this results in an unusually heavy charge against the work. The Chain Belt Co. of Milwaukee, Wis., has installed a special apron-type conveyor with chutes for carrying heavy drawn steel shells

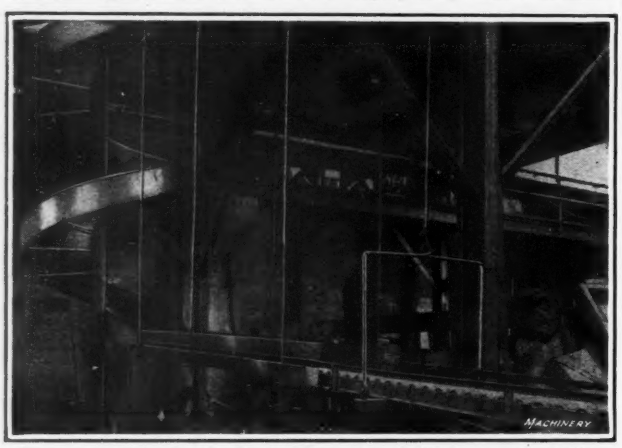


Fig. 89. For unloading flywheel castings from freight cars, the Cadillac Motor Car Co. of Detroit, Mich., has a spiral steel chute leading down from the platform on which the load is discharged. The castings are ejected from the chute onto a gravity carrier

Fig. 90. This illustration shows the gravity carrier leading from the spiral chute shown in Fig. 89 to the machining shop. The carrier is suspended on cables so that it may be raised to provide the necessary head room for a team to go underneath

stops and other safety features are provided, making the machine largely automatic in its action, one ordinary laborer being all the help required.

Bringing the Saw to the Shafting

The Mechanical Appliance Co., Milwaukee, Wis., has developed a novel method of handling the steel shafting that it uses in the manufacture of its product. Shafting of from ½ to 3½ inches in diameter is used. It was found that a great amount of time and labor was consumed in bringing heavy shafting to the hacksaw from the racks onto which the shafting was loaded from the trucks. Instead of bringing the heavy shafting to the hacksaw, the motor-driven hacksaw is brought to the pile of shafting. The shafting is stacked onto the racks from the trucks. The hacksaw is raised to the correct level of the shafting by means of a tiering machine built by the Economy Engineering Co. One operator is able by means of this arrangement to take care of the complete operation of cutting off shafting from ½ to 3½ inches in diameter. As many as six men were formerly employed to carry the long pieces of the heavier sizes of shafting to the saw.

Adapting Transportation Methods to Requirements of Shop

In working out methods of progressive assembly for use in his factory, a manufacturer must bear in mind the volume of work which is to be handled. It would not pay to install a complex equipment of conveyors, trolley systems, etc., to facilitate handling work unless the volume of product was sufficient to keep equipment of this kind employed so that a reasonable return would be earned on the investment. Even in highly organized shops handling a moderate volume of product each day, little attempt is made to employ a complete outfit of mechanical contrivances for handling the work, because it is realized that there would be little likelihood of obtaining a satisfactory return on the investment. Recently we have seen some exceptions to this rule that are probably due to the condition of the labor market. Unskilled labor has been so scarce and has commanded such exceptionally high prices that some manufacturers have substituted mechanical means of handling as far as possible. This has been particularly true in shops engaged in certain munitions work where the necessity for making deliveries at an early date has demanded the employment of every possible means to increase production rates.

Plants handling an extremely large volume of product are best suited for the installation of complete systems of conveyors, trolleys, gravity carriers, chutes and other forms of equipment arranged in combination, so that as soon as one workman or group of men have completed their task on a given piece of work it may be placed on a mechanical carrier that will convey it to the department where the next operation is to be performed. Aside from the reduced cost of production made possible through the reduction in help, the employment of mechanical carriers has another important feature which commends it to the attention of manufacturers operating large factories in which there is likely to be a congestion of machines and product. Unless mechanical carriers are used, the alternative is to make transfers on trucks pushed by hand or by power, and the handling of a large amount of work in this way is bound to create confusion—especially when aisles are blocked or there is other interference with the movement of the trucks.

In an article of this kind it is the aim to explain fundamental principles and describe methods which the average manufacturer can employ in his own shop. On this account, the methods of handling material and product in extremely large plants are not entered into in detail, inasmuch as they require complete installations of mechanical transporting facilities and an engineering staff capable of laying out all kinds of equipment. Nevertheless, all manufacturers will be interested in reading of the equipment employed in the factory of the Willys-Overland Co., Toledo, Ohio, for the final work of assembling parts of automobiles.

General Arrangement of Equipment

The department in which the final assembly is conducted is laid out with four tracks, down which the automobiles are

pulled by chain conveyors that were installed by the Link-Belt Co., Chicago, Ill. The automobile frame is placed on this track and a hook on the chain conveyor takes hold of the front axle to draw the frame along. Features of the progressive method of assembly have been explained previously, so they need not be considered here. The point of greatest interest is the arrangement of the auxiliary carrying systems that bring parts to the main assembling track at the different points where the parts are to be assembled onto the car. There are four of these tracks that run lengthwise down the shop, and a large number of conveyors running crosswise. Each of these cross conveyors brings such parts as lamps, mud guards, radiators, etc., to the four main assembling tracks at those points where the different parts are to be added to the car; and all the time that this continual stream of parts is running across the shop, the automobiles in course of assembly are running lengthwise, so that as each car passes down one of the assembling tracks the different parts which go to make a complete car are brought over to the assembling track and secured in place. This system has been carried to such a degree that when the gasoline tank is delivered to the assembling track by one of the cross conveyors, it contains sufficient gasoline to allow the completed automobile to run out of the assembling department on its own power.

In the various manufacturing departments, as well as in the assembling department, use is made of conveyor systems for handling work in course of manufacture and finished parts. For the parts of a product as complex as a modern automobile, it will be evident that a great variety of carrier systems must be provided, and in the Willys-Overland plant use is made of practically all the standard conveyors, trolleys, etc. For instance, completely assembled motors are handled on apron-type conveyors or on trolley systems, from which they are suspended in a suitable sling. Advantage is taken of the circular form of wheels and tires, and they are rolled down gravity carriers. Gravity is also employed for carrying certain forms of castings and similar parts, but it is necessary to provide some form of roller conveyor, because the castings could not be rolled. In the case of lamps, mud guards and many other parts of a like nature, there is no better method of carrying than on a trolley system, and extensive use is made of this form of equipment. In addition to standard conveyors, many special forms of equipment have been provided for handling parts of unusual form, and a general idea of the diversity of the carriers that have been installed by the Willys-Overland Co. will be gathered from the illustrations presented in this and the preceding installment, showing views in this company's plant. These are by no means complete, but they serve to give an idea of the great variety of methods of handling that have been adopted to meet different conditions and the care that has been taken by this company's engineering department in studying all the available methods and adopting those that have the greatest number of features to commend them.

Development of Special Forms of Carriers

In working out the transportation system for any factory, the engineer in charge of the work has at his disposal numerous forms of standard equipment that are manufactured by plants making a specialty of this work, and it is desirable, whenever possible, to adopt the use of standard forms of equipment, because a plant specializing in such work can usually furnish equipment at a price considerably lower than that at which special equipment could be made for a given service. There are many cases, however, where the nature of the work to be handled is such that it demands the use of special equipment, and under those circumstances the engineer who is laying out the transportation system would be called upon to design suitable equipment for the work. This may involve the development of special methods of handling, but in many cases it will be found possible to use standard equipment and add special features to adapt it for a given service.

Where it is found that standard equipment cannot be obtained for handling the work, the next step of the engineer should be to ascertain whether certain standard forms of equip-

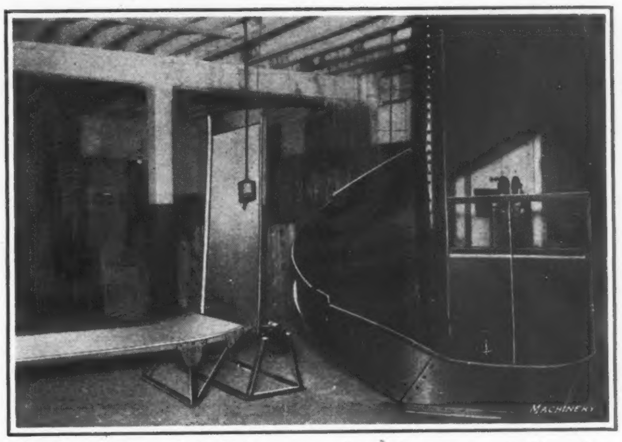


Fig. 91. Where spiral chutes are employed to carry work through a building, it is often desirable to discharge the load on some of the floors through which the chute passes. The chute shown (Mathews Gravity Carrier Co., Elwood City, Pa.) has a branch for this purpose

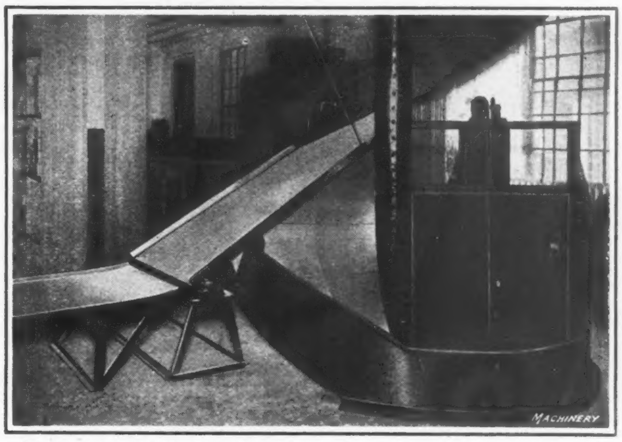


Fig. 92. This illustration shows the same equipment shown in Fig. 91, but here connection is made with the branch chute. Attention is called to the fire door; this is held open by a fusible link, which will melt and allow the door to close automatically in case of fire

Fig. 93. In the Detroit Wire Spring Co.'s shops extensive use is made of chutes for carrying work from upper to lower floors. Here we see chutes down which coiled springs are delivered to the department in which these springs are assembled into strips

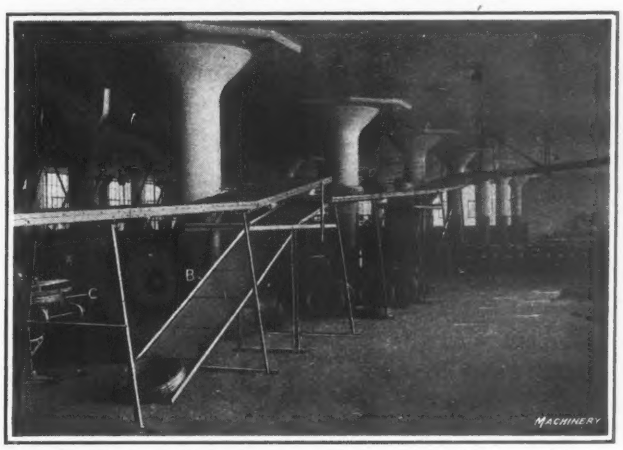


Fig. 94. Where gravity carriers are used it is desirable to provide for discharging the load at different points in the shop. In the illustration provision is made for raising sections of the carrier at different points, so that the load may run under the rollers and slide down the chute

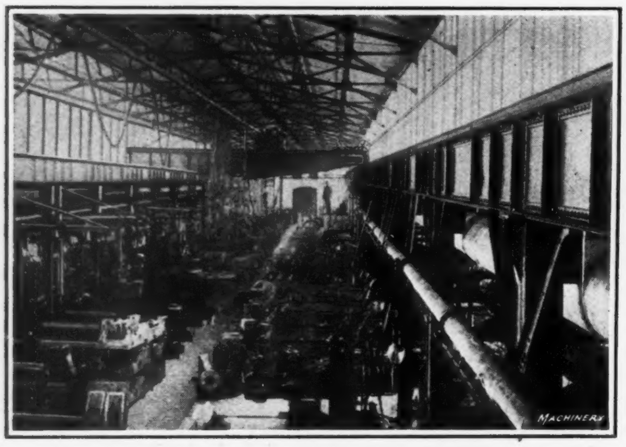


Fig. 95. In some machine shops compressed air is preferred to electric power. Such a case is shown in this illustration. Attention is called to the way in which the hose connection to the pneumatic motors is hung in festoons so that there will be plenty of length to enable the crane to run to the far end of the building

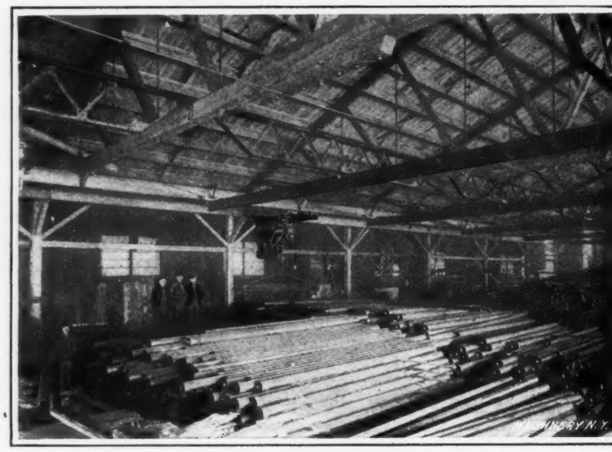


Fig. 96. When a number of trolley hoists are used on rails running parallel to each other, it is desirable to provide means of transferring trolleys from one rail to another. This can be done with a transfer bridge carrying a section of rail that may be lined up with some one of the main rails. The hoist is run onto the rail on the transfer bridge

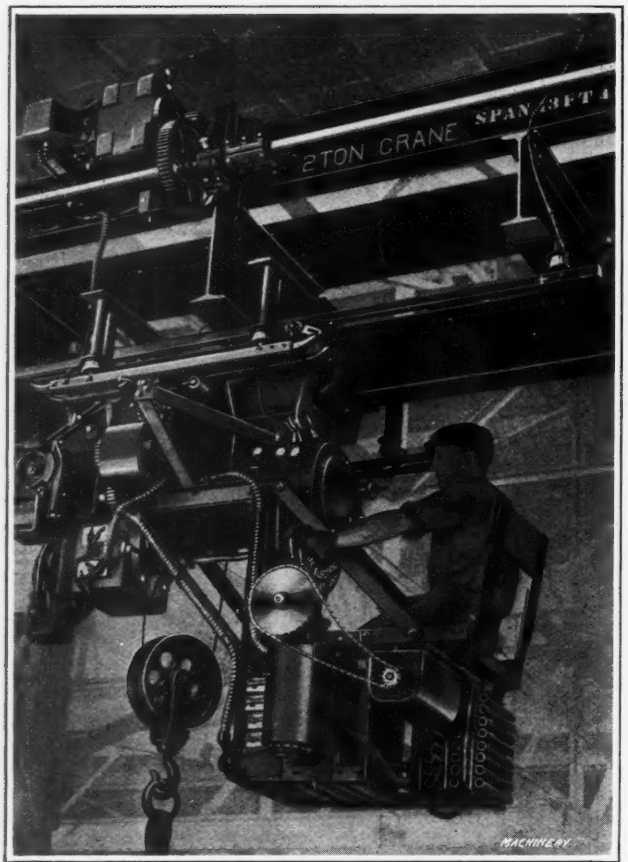


Fig. 97. This illustration shows a close view of the trolley in place on the rail of one of these transfer bridges. The trolley is locked while the bridge is in motion so that it cannot run off the rail. This equipment was built by the Sprague Electric Works, New York City

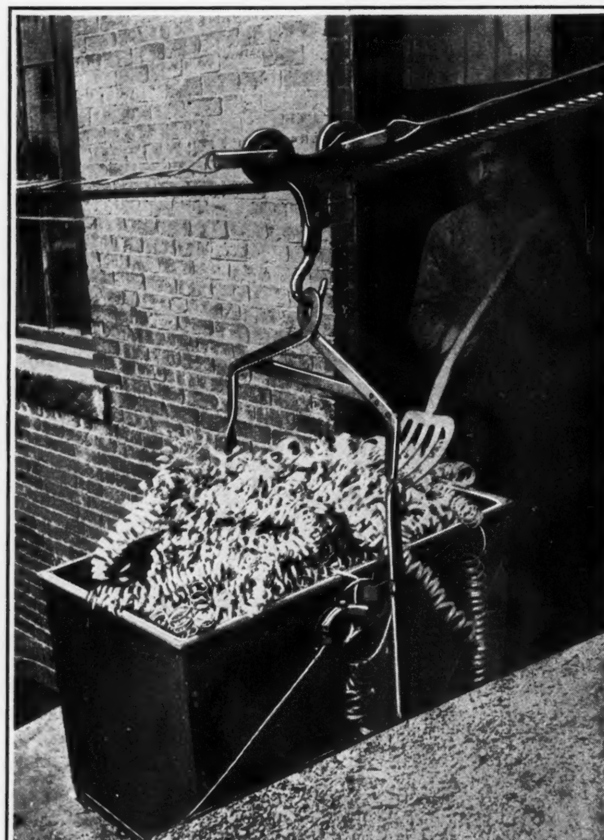


Fig. 98. In machine shops that produce large quantities of chips means must be provided for hauling these chips away to the scrap pile. The illustration shows a skip loaded with chips, which is pulled over to the scrap pile by a laborer, who removes the contents with a pitchfork

Fig. 99. In manufacturing military rifle stocks, each stock must be finished so as to present a good appearance. In the United States arsenals special trucks are used to carry the finished rifle stocks to prevent marring finished surfaces

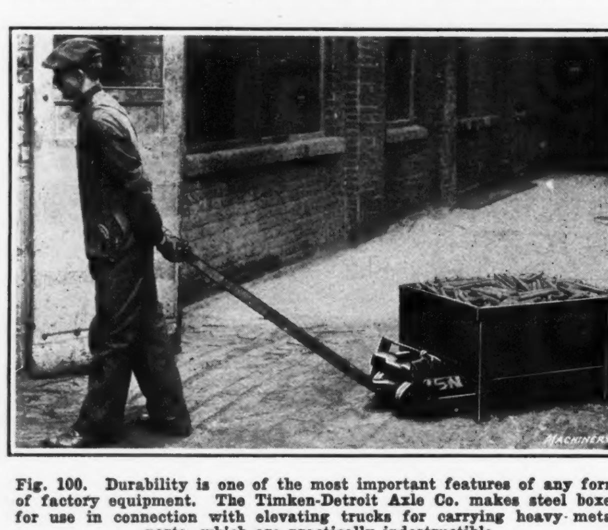


Fig. 100. Durability is one of the most important features of any form of factory equipment. The Timken-Detroit Axle Co. makes steel boxes for use in connection with elevating trucks for carrying heavy metal parts, which are practically indestructible

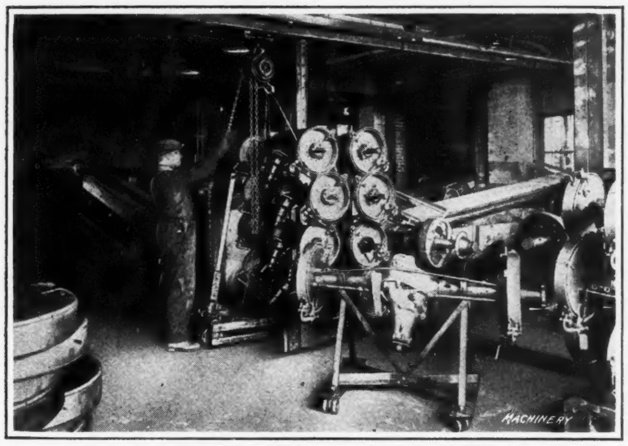


Fig. 101. In the Timken-Detroit Axle Co.'s factory axles are delivered to local factories on special motor trucks. A trolley hoist lifts an axle off the small truck onto a stand; when eight axles have been put on the stand it is picked up on an elevating truck and carried to the motor truck

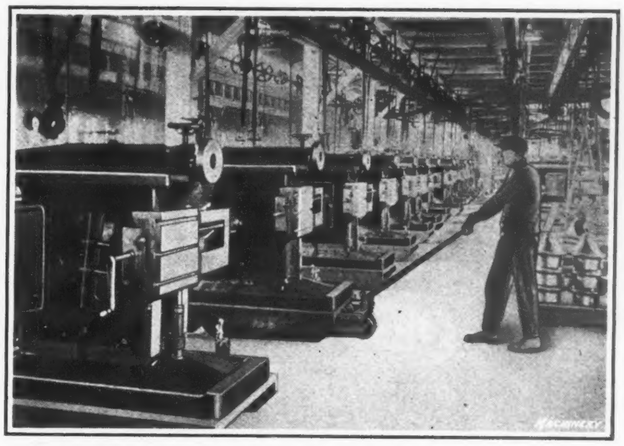


Fig. 102. This illustration shows how elevating trucks built by the Stuebing Truck Co., Cincinnati, Ohio, are used for handling the product of the Cincinnati Shaper Co. Machines are placed on skids so that they may be handled in the minimum time. The elevating truck enables the machines to be easily picked up and taken to exactly the desired spot

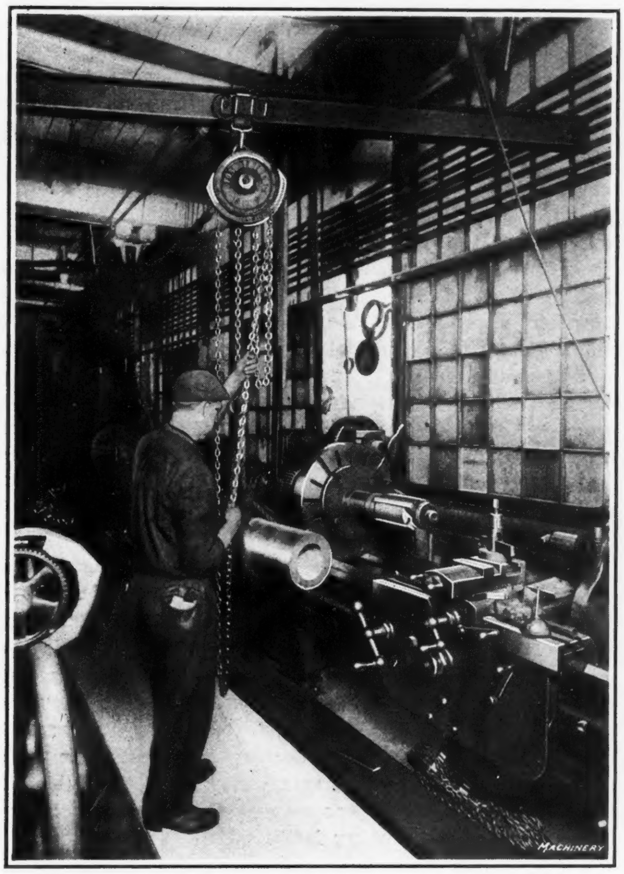


Fig. 103. In setting up heavy work on machine tools, it is desirable to use a trolley hoist in connection with each machine to conserve the operator's time. This illustration shows a chain hoist built by the Ford Chain Block & Mfg. Co., Philadelphia, Pa.

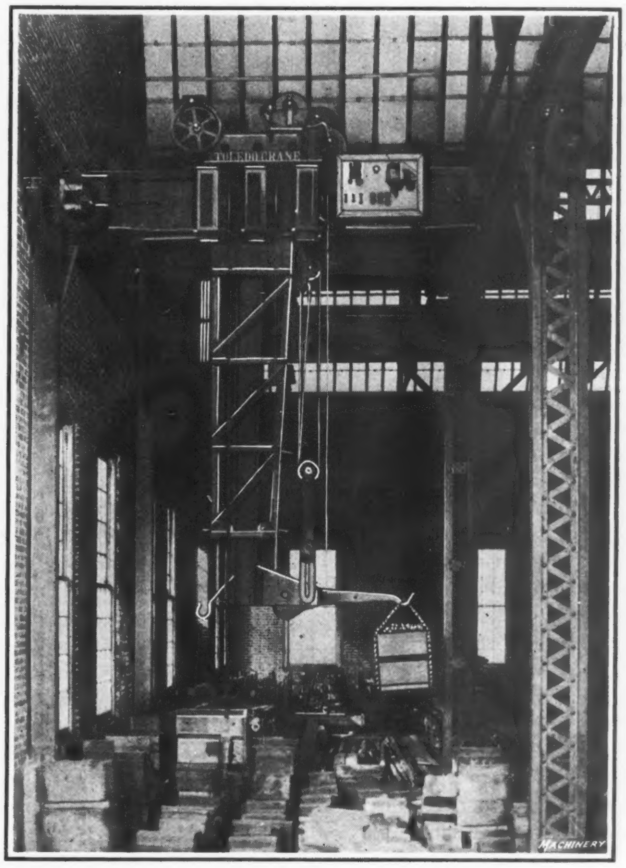


Fig. 104. The crane built by the Toledo Bridge & Crane Co., Toledo, Ohio, is used for placing dies on hammers or presses and transferring them to and from the storage department. The arm that carries the lifting hook is raised and lowered by means of cables

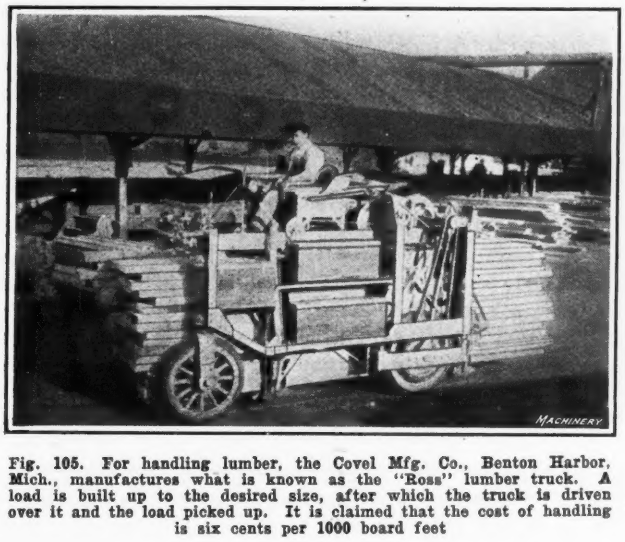


Fig. 105. For handling lumber, the Covel Mfg. Co., Benton Harbor, Mich., manufactures what is known as the "Ross" lumber truck. A load is built up to the desired size, after which the truck is driven over it and the load picked up. It is claimed that the cost of handling is six cents per 1000 board feet

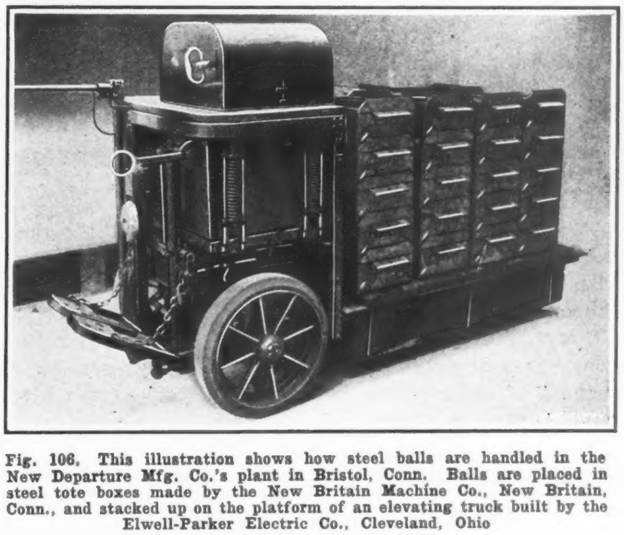


Fig. 106. This illustration shows how steel balls are handled in the New Departure Mfg. Co.'s plant in Bristol, Conn. Balls are placed in steel tote boxes made by the New Britain Machine Co., New Britain, Conn., and stacked up on the platform of an elevating truck built by the Elwell-Parker Electric Co., Cleveland, Ohio

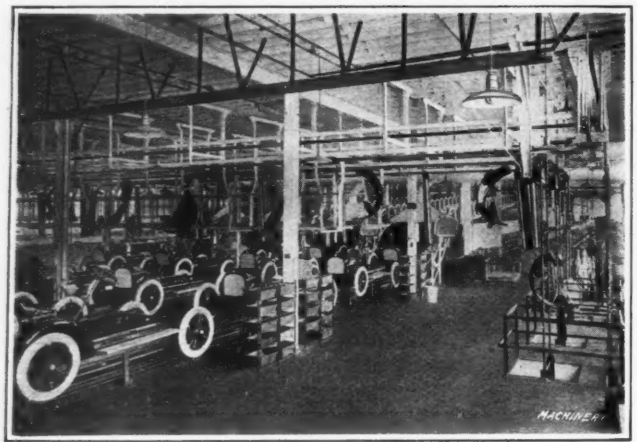


Fig. 107. In handling the progressive assembly of automobiles, the Willys-Overland Co. has tracks down which the cars are run during the process of assembly. Overhead trolley systems running at right angles to the line of travel of assembling tracks carry various parts to the assemblers

Fig. 108. Reference has already been made to the desirability of using combinations of equipment for handling material and produce which is being passed through a factory. This illustration shows the combination of an elevator, a gravity carrier and an apron-type conveyor for raising work from the lower floor and transferring it through the shop

ment furnished with special attachments for holding work, etc., cannot be made to meet his requirements. If so, it will be more desirable to use such equipment than to attempt to produce a complete special outfit. For instance, the Detroit Wire Spring Co., Detroit, Mich., recently laid out a complete new plant for the manufacture of automobile cushion springs. It was a point of great importance to provide methods that would enable the large volume of work constantly going through the shops to be passed along with the greatest possible dispatch. Certain features of this company's equipment are illustrated in this article, and it will be seen that mechanical carriers are employed for dipping work into japanning tanks, carrying the work into baking ovens, and many other purposes where manual labor would ordinarily be employed.

A bundle of coiled wire springs does not weigh very much, but it is of necessity quite bulky and calls for some special method of handling. The Detroit Wire Spring Co.'s transportation equipment consists largely of trolley systems, and to provide for carrying wire springs on trolleys it was necessary to develop special forms of carriers which could be used in conjunction with standard trolleys. This was worked out by arranging baskets for handling bundles of coiled springs and long racks on which a number of assembled cushion springs could be suspended. The adoption of this method enabled the engineering department of the Detroit Wire Spring Co. to buy standard hoists, trolleys and rails from manufacturers of this type of equipment, and then merely make its own racks, so that there was little special work to be done in getting everything ready for use. Needless to say, this was a less expensive installation than would have been a special outfit built for a particular class of service.

* * *

AFTER THE WAR—WHAT OF MACHINERY EXPORT?[1]

Opinions regarding the export of machinery after the war range from extreme pessimism to broadest optimism. England and Germany have been the most potent competitors of America in the machinery market, but Germany is arrayed against us, and it is reasonable to premise that the nations now at war will later cooperate with their present allies along economic lines. Further, for a considerable period at least, the products of Germany will find little favor among the Allies, with the possible exception of Russia. It would thus appear that for some time we may reasonably anticipate having only England as a serious competitor. Later, Canada may become an important factor in the machine-tool industry.

Although the present great demands on the resources of Europe have encouraged in England the highest possible development of those classes of machinery that have a direct bearing on the war, there has probably not been a similar development of automatic and other types of machines that until a few years ago were peculiarly American. Therefore, in many of these lines we may expect to occupy a commanding position in the industry.

Another factor that will loom large in our machine-tool industry is the labor question. While there may be no reduction in wages in this country for a number of years, because of the labor shortage, etc., wages abroad will so increase as to materially aid our export business. Further, the return of those soldiers, from the less enlightened sections, who have been prisoners in Germany will create among their people desires for the better things of life, and they will be satisfied with nothing short of an approximate fulfillment of these desires. However, regardless of the apparently favorable competitive conditions and the essential needs for the work of restoration, as well as the meeting of normal demands, our prosperity following the war will be largely dependent on the restoration program. Will our allies inaugurate a "pay-as-you-go" policy, which contemplates reconstruction through their own resources, or will they avail themselves of America's credit so that the devastated districts may utilize to its fullest capacity the labor of their remaining populations?

Indications are not lacking that Europe contemplates an eventual industrial development far beyond that attained prior to the war, thereby utilizing a large proportion of that great army of metal workers that during the present crisis is supporting the armies at the front. Heavy purchases of machinery are being made, largely for use after the war. Besides, many difficulties have developed during the war which seriously interfere with satisfactory financial arrangements; this has been most evident as affecting sales to Russia. Also for some time after the war we may expect to be handicapped through a lack of shipping facilities.

Assuming that the views here expressed as to the immediate future in Europe are far too optimistic, are there other fields wherein we may develop an outlet for our surplus product? Canada has but recently experienced the prosperity that comes from intensive industrial effort; nothing short of continued development along these lines will satisfy these "Yankees of the North." South America, which has purchased German goods so heavily, is now looking to us for supplies. India, South Africa and Australia will favor England whenever possible, but China, although regarded by Japan, from a commercial standpoint at least, as her rightful heritage, strongly favors American things in her industrial upbuilding.

One factor that will decrease industrial unrest and materially improve our export business is the establishment of fair standards of production and wages. If this problem is correctly solved, one of the greatest handicaps to an aggressive seeking of world trade will be removed. There is also a feeling on the part of the foreign buyer that when our business is good at home, scant attention is given business abroad; as soon as business is less prosperous, there is a rush to dispose of our products in the foreign market. If the foreign buyer of machinery is given value received in the goods purchased and the attention necessary to produce the results to which he is entitled, he will be loyal to his source of supply.

[1]Abstract of a paper read at the Export Conference, Springfield, Mass., June, 1917, by C. O. Smith, sales manager, Norton Grinding Co., Worcester, Mass.

GAGES FOR TIME-FUSE PARTS[1]

PROBLEMS IN THE MANUFACTURE OF GAGES FOR RUSSIAN TIME FUSES AND METHODS BY WHICH THEY WERE SOLVED

BY DONALD A. BAKER[2]

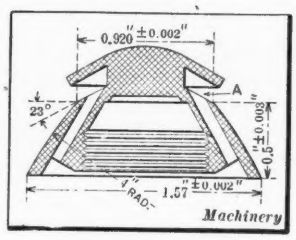


Fig. 1. Cap of Russian Time Fuse

MANY of the gages and jigs used in the manufacture of Russian time fuses present unusual problems to the toolmaker. In order that the use of the gages and jigs may be clearly understood, the parts of the fuses are illustrated; Fig. 1 shows the cap, Fig. 2, the top ring of the fuse, and Fig. 3, the body. In Fig. 4 is shown a gage for testing the relation of the various holes in the top ring. As a number of these gages are required by the inspectors, and as they wear rapidly, a master gage, Fig. 5, is used for testing them and keeping them standardized. This consists of a piece of annealed tool steel, bored out to fit over the center plug of the working gages and having the necessary holes properly located for testing the gages. The special tools and fixtures required for making the master gage were so designed that they could be used in the manufacture of the working gages. The master gage is made as follows: After a piece of steel is roughed out and a 5/16-inch hole reamed in its center, it is placed on a mandrel and turned and faced to the proper size, enough material being left on the faces to grind them perfectly parallel. After grinding, hole *A* is bored, the work being strapped to an angle-plate, swung on the bench lathe faceplate. The angle-plate is located the proper distance below the center by plug *A*, Fig. 6. One end of the plug passes through the hole in the faceplate, and is held in a spring chuck, while the other end is turned to the proper diameter for locating the angle-plate when the plate is brought against it, as shown.

The work is then located approximately on the angle-plate, and the lathe spindle is turned until the face of the plate, with the work attached, is at right angles with the top of the lathe bed; this is tested by placing a parallel across the ways of the lathe and using a square from the surface of the parallel. An indicator attached to a surface gage is then used to set the work central, being brought first against one edge and then against the other, the lathe faceplate being turned a half revolution for this purpose. After the work is securely strapped, it is tested to see that its position was not changed when tightening the clamps. The work is then center-drilled with a combination drill and counterbore. It is drilled a little smaller than the desired size, and a small boring tool is used to enlarge and true up the hole sufficiently to start a reamer; the starting hole must be of the proper size for the reamer to fit into it. This operation of boring and reaming is repeated several times; for instance, 0.002 inch may be removed with the first reamer, about 0.001 inch with the second, and 0.0005 inch with the third—the last being more of a burnishing than a cutting operation. The finishing reamer should leave between 0.0002 and 0.0005 inch to be removed with a solid lap. The lap is made of either brass or copper, preferably the latter, charged with washed flour of emery. It is held in the fingers and the work revolved against it.

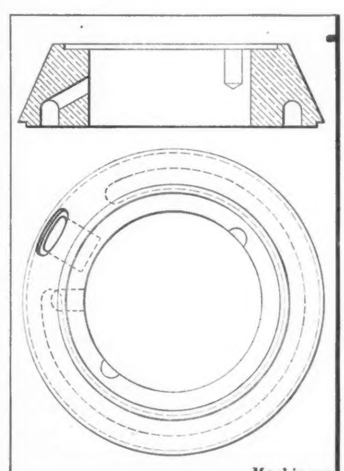


Fig. 2. Top Ring of Russian Time Fuse

Boring Angular Hole in Master Gage

For the next operation, boring the angular hole *B* and the two half holes *C* and *D*, Fig. 5, a special angle-plate is used on the bench lathe faceplate. This consists of a flat plate *A*, Fig. 7, which is ground perfectly parallel, and a plate *B*, shaped up and ground accurately on the faces and edges, and having accurate angles. An accurate angle-plate and sine bar are used to make the angles correct. The master gage is placed over a plug inserted in a 5/16-inch hole *C* bored and reamed near the center of this plate. The plate also contains two holes *D* and *E* for locating and boring the two half holes in the master gage; while this is being done, plate *B* is used separately from plate *A*. These two holes are carefully located by the following method: First a hardened, ground and lapped plug *A*, Fig. 8, is made. One end of this plug fits the center hole in plate *B* and the other end is ½ inch in diameter; near the middle is a disk-like section. The diameter *C* of the disk is such that when two ½-inch standard jig buttons are placed directly opposite, one on each side of the center plug and against its edge, as shown, their center distances will be equal to the center distance of the two holes to be bored.

The position of the buttons having been laid out roughly and the holes for the button screws having been drilled and tapped, the buttons are put in place and held lightly by their screws. The plate is then placed on its edge, as shown, and the sine of the angle having been found by calculation, the tool *D* is used to set one of the buttons in position. This tool consists of a tool steel base *A*, Fig. 9, which is hardened, ground and lapped on the bottom, and several lengths of drill rod, the ends of which have been hardened, rounded off and lapped smooth. These rods are held in the body and can be clamped securely in place by screw *C*, the body being split at *B*. The rods are first set to the proper distance from the base of the tool by the aid of a micrometer, one rod being set to the distance from the bottom of the plate to the edge of a button, and the other to the distance from the side of the plate to the edge of a button. The rods are adjusted by lightly tapping them, as when setting an ordinary firm-joint caliper. Sometimes the rods are threaded, when they are adjusted by screwing in or out. To locate the buttons, the plate is set first on one edge, then on the other, using the tool as a feeler by sliding it along the surface plate underneath the button, and tapping the button in the direction that the feeler shows it should go, until the "feel" is just right. This method applies to the setting of any button, but as in this case one dimension is supplied by the central plug, only one dimension is needed—that from the bottom of the plate to the edge of the button.

The second button on the plate can be adjusted by using a knife-edge straightedge to get the two buttons and the plug dead in line. The straightedge is tried first on one side and then on the other, and the screw of the second button is tightened, when finally adjusted, so that the straightedge no longer "rocks." After the buttons are set in the proper position, the plate is strapped lightly to the lathe faceplate and one of the buttons indicated until it runs true. Then the straps are tightened and the button again indicated to make sure the clamping has not disturbed the setting; if it still runs true, the button is removed and the hole bored, reamed

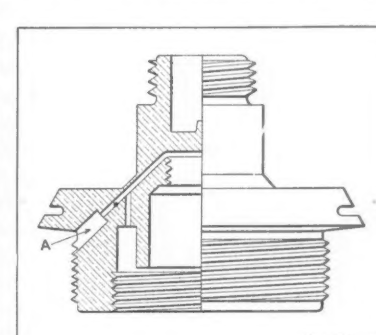


Fig. 3. Body of Russian Time Fuse

[1] For other articles on making fuses, see "Manufacturing Parts of Type 80 Time Fuses," in the December, 1916, number of MACHINERY, and other articles there referred to.

[2] Address: Williams Mfg. Co., Ltd., Montreal, Canada.

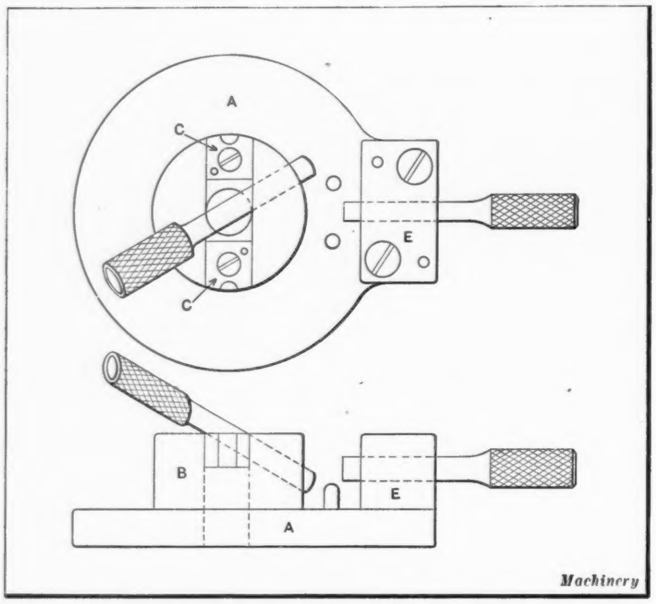


Fig. 4. Gage for testing Holes in Top Ring

and lapped as described for the master gage. After the first hole is finished, the second is treated in a like manner and the plate completed.

To use this master plate, a plug is placed in the center hole and the master gage is placed over this, being held in position by putting a few drops of solder around the edge. Next a special collet with a hole bored through it is placed in the lathe, as shown in Fig. 10. In the end of the collet is placed a piece of 5/16-inch hardened drill rod *A*, the end of which is ground and lapped to fit the holes in the master plate. After this collet is in place and the end of the plug is ground, the faceplate is put on and indicated on its face, to make sure that it runs true; then the master plate, carrying the master gage, is located by putting it over the center plug in the lathe, and strapped fast in the proper position for one of the two half holes to be bored. The remainder of the operation is the same as described for the other holes. The second half hole is treated in the same manner.

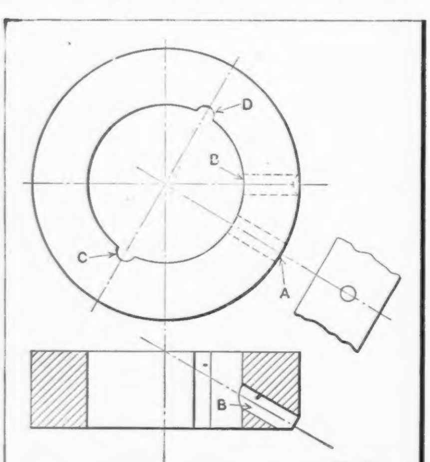


Fig. 5. Master Gage for testing Gage shown in Fig. 4

The method of boring the angular hole *B*, Fig. 5, is one seldom used. Although the locating of this hole is usually considered one of the things that must be found by the most unsatisfactory cut-and-try methods, it may be accurately done as follows: The two plates *A* and *B* are screwed and doweled together, as shown in Fig. 7, converting them into a special boring fixture, or master angle-plate. Then a special plug having a hardened steel ball *F* at one end is made up. Commercial steel balls are used, as they are readily obtainable and are usually accurate as to sphericity. This plug is placed in the 5/16-inch hole in the plate and the ball is adjusted with micrometers until its center is as far from the face of the plate as the sine of the angle of the hole to be bored. The boring fixture is then strapped to the lathe faceplate and the ball indicated until it runs true, after which the ball and plug are removed, a short, straight plug substituted, and the master gage located in place again over this plug, being held by solder, when it is ready to have the hole *B* finished in the usual way.

Finishing Center Hole of Master Gage

The last operation on the master gage is finishing the center hole to size, stock having been left so as to bore the two half holes through solid steel. The gage is held in a cast-iron spring chuck of the "step" variety, and the hole is roughed out. But as these chucks are not absolutely accurate, the finishing is done in a brass chuck like that shown in Fig. 11. This chuck consists of a special lathe collet *A*, to one end of which is screwed and soldered the piece of brass *B*. The collet is placed in the lathe and the brass piece bored out to within a couple of thousandths inch of the size of the outside diameter of the master gage. It is heated with an alcohol lamp

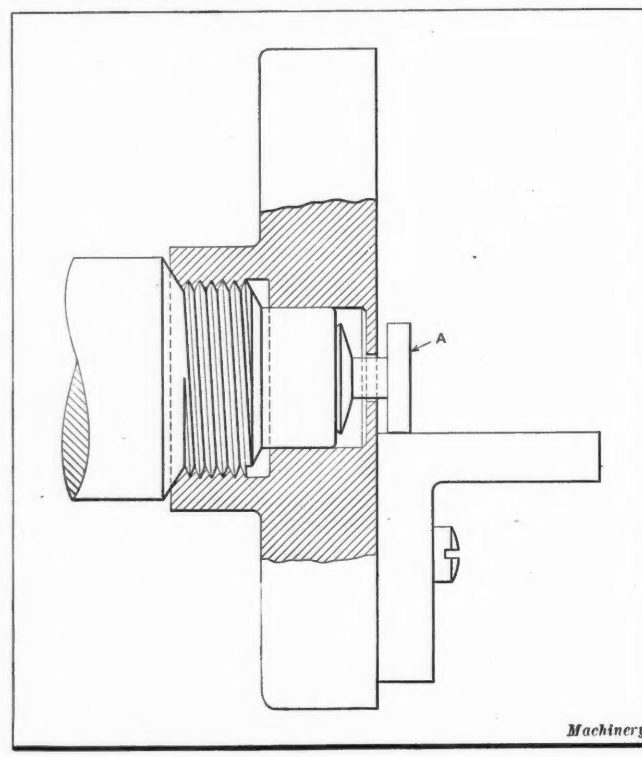


Fig. 6. Angle-plate used to support Master Gage when it is being ground

until the gage will slip into it, and is then cooled with a piece of waste dipped in water; the shrinkage of the brass will hold the gage securely and accurately. The gage is then bored in the regular way, care being taken on the last few cuts not to break down the corners of the two half holes. In boring, 0.01 inch is left for finishing with the bench lathe grinder, and in this operation from 0.0002 to 0.0005 inch is left to be taken out with a lap. When lapped, the gage is ready for use.

Making Working Gages

In making the working gages, practically the same methods are used. These gages consist of a base *A*, Fig. 4, a hardened tool steel locating and gaging nose *B*, to which are screwed and doweled the half-hole gaging parts *C*, and hardened steel block *E*, which is screwed and doweled to the base.

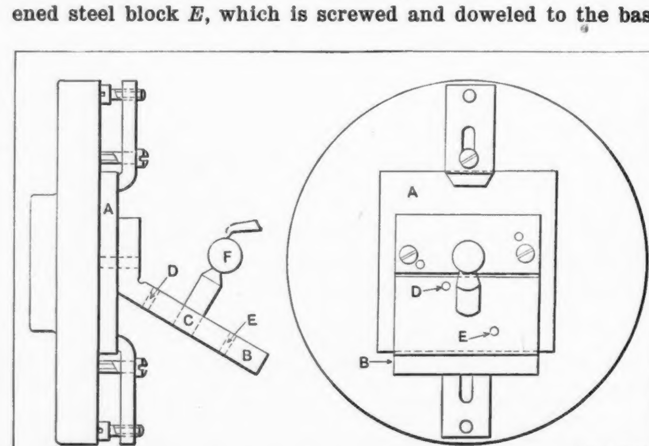


Fig. 7. Special Master Plate for holding Master Gage

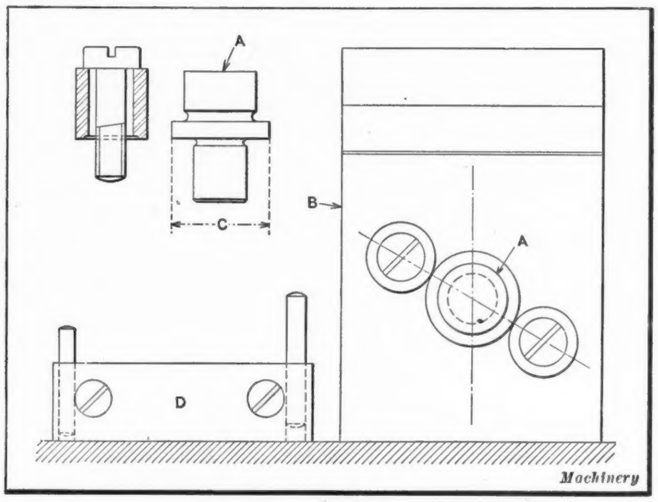


Fig. 8. Plugs for locating Half Holes in Master Plate

In addition there are four hardened, ground and lapped plugs, only two of which are shown; the other two are double ended "Go" and "Not Go" gages for the half holes.

To make this gage, the base *A* is first machined, the two flat sides being ground parallel and smooth; then the 5/16-inch hole in the center is bored, after which the block *E* is made in the usual way, placed on the base and located approximately. After the screw holes are located, drilled and tapped, the piece is fastened lightly in place and lined up properly with the center hole in the gage base. It is then fastened securely by the screws, and the dowel-pin holes are drilled and reamed and the dowels placed in them.

The next step is machining the center plug, or locating nose *B*, which is done in practically the same manner as was described for the master gage, using the same master plate and master angle. A piece of tool steel is roughed out and a hole 0.002 inch less than 5/16 inch is bored and reamed in the center. The piece is then placed on a mandrel and the outside turned to within 0.01 inch of size and the top and bottom are faced off. The bottom, being slightly under-cut, leaves a rim 0.004 or 0.005 inch around the edge. This edge makes it impossible for any bulging, caused in hardening, to prevent the bottom from being lapped to a true surface again without grinding on the surface grinder. After the piece is turned and faced, it is removed from the mandrel and placed on the milling machine, and a 5/16-inch slot, 1/4 inch deep, is milled across the face to take the two pieces that are to gage the two half holes. Screw and dowel holes are then made in it. In boring the angular hole, the same methods and fixtures are used as in making the same hole in the master gage. After this hole is bored and reamed, the piece is hardened. The scale is then lapped out of the center hole, and a short piece of drill rod is caught in the lathe chuck and ground in place until the piece can be wrung onto it. In this position the piece is ground to within 0.0005 inch of size and then lapped, to remove the remainder. Next, the two pieces of soft tool steel are fitted to the 5/16-inch slot milled across the face of the plug, leaving enough projecting at each end so that when the half holes are being made there will be stock all around to support the reamers, etc. In making these holes, the master plate used in making the master gage is again used. In boring, about 0.002 inch is left in the holes, so that after they are hardened and replaced, they can be again set up and ground with a diamond-charged lap used in the bench lathe traverse spindle grinder. Afterward the surplus stock on the ends of the inserted pieces is ground off on the tool grinder freehand, the final finish being given by placing the piece that carries them over a plug, previously ground in the lathe chuck, and finishing with the bench lathe grinder.

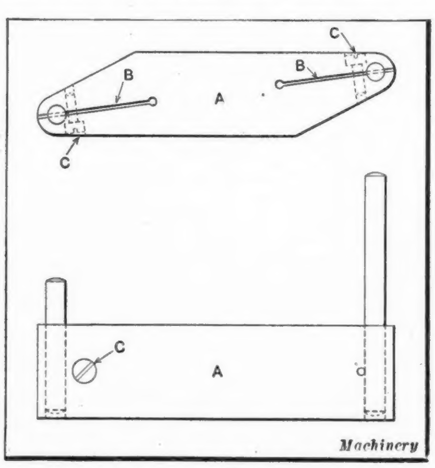


Fig. 9. Tool for locating Plugs shown in Fig. 8

The gage is then ready to assemble. This is done by placing the gage over a 5/16-inch plug that is inserted in the hole in the base. Then the master gage is placed over it and the two plugs of the proper size are inserted in the two half holes and in the corresponding holes in the working gage, while a third plug is put through the block *E* and entered into the proper hole in the master gage. In this position, the center plug, or locating nose of the working gage, is ready to have the dowel and screw holes transferred to the base. After these holes are finished, the dowels inserted and the nose secured by the screws, the gage is ready for use. The angular hole, and all others that are likely to become out of true in hardening and which cannot readily be trued up by other means, are ground out by using a diamond lap where they are too small for an emery wheel to be used.

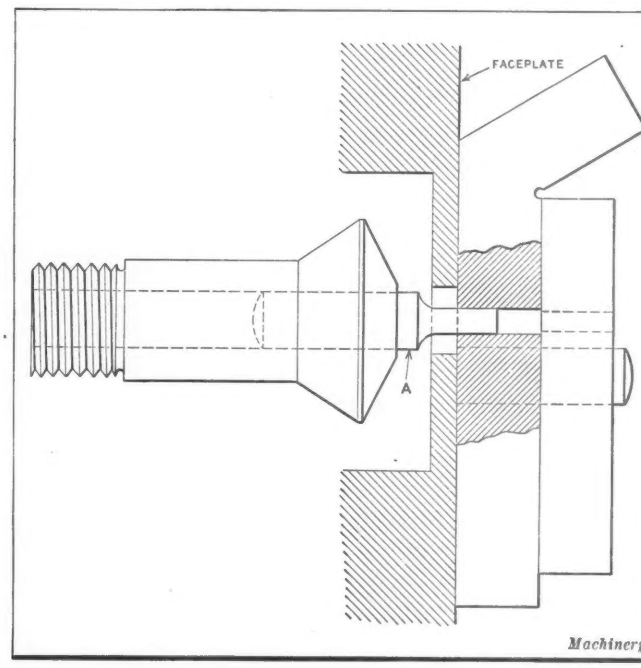


Fig. 10. Special Collet used in making Master Gage

Height Limit Gage

At *B*, Fig. 12, is shown a limit gage for testing the height of the under-cut *A* in the fuse cap, Fig. 1. For the benefit of those who like to work out interesting and practical problems in toolmaking that require a knowledge of simple shop trigonometry, the dimensions of the gage and the cap are given here just as the workman gets them. The gage consists of five pieces; *A* and *B* form the body and are doweled and riveted together by the pin *D*, which is a snug-fitting piece of drill rod. Pins *C* are driven into body *B*, the center hole being for clearance to allow the pins to be driven out.

Fig. 15 shows the master plate on which the two parts forming the body were made. This consists of a flat plate *A* ground parallel on the sides and two long edges. In it are

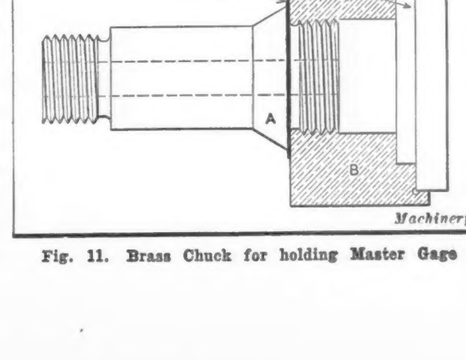


Fig. 11. Brass Chuck for holding Master Gage

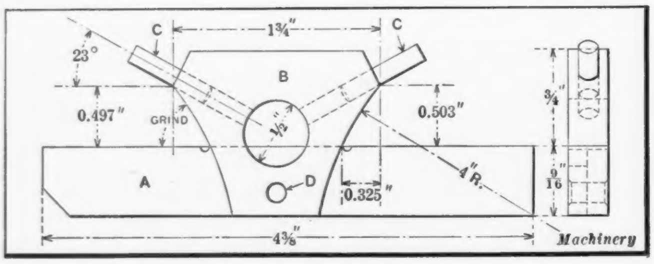


Fig. 12. Gage for testing Under-cut in Fuse Cap

bored four holes *B*, *C*, *D* and *E*, and two pins *F* and *G* are located on it. The positions of the holes, of course, are found by calculations involving trigonometry. After the dimensions have been found, the plate can be laid out roughly, the holes drilled and tapped, and jig buttons screwed in place and then located accurately by using micrometers, a height gage, or other convenient means. In this case, the hole *B* was first located approximately and the center punched. Then the plate was swung on the faceplate of a lathe, and the hole drilled, bored and reamed to size, but without taking any particular pains to keep it in exact relation to any other part of the plate, as it was afterward to be used as a starting point.

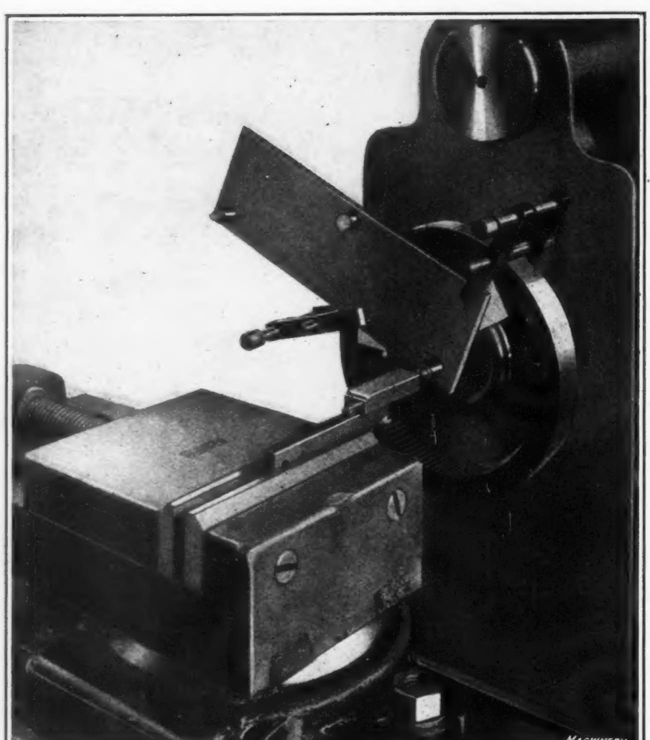


Fig. 13. Locating Holes on the Master Plate

After hole *B* was finished, the jig buttons were put in place and accurately located for holes *C* and *D*. As we had no engine lathe large enough to swing the plate when these holes were being bored, a milling machine was used, as shown in Fig. 13. Lacking a proper faceplate for this machine, a large internal gear that was part of a high-speed milling attachment was put in place on the machine and a light cut taken off its inside face to make sure that it ran true, holding a lathe tool in the miller vise. Two blocks that had been ground square on the surface grinder were then placed against the trued face of the gear, and the master plate was clamped back against them as shown; then the buttons were trued up by the indicator, which was held fast in the miller vise. After truing them, the work was clamped more securely, again indicated, and the buttons were removed; a boring tool was put in the miller vise in place of the indicator, and the holes were bored true, using the milling-machine feeds.

After the end holes *C* and *D*, Fig. 15, were finished, plugs were inserted and the button for hole *E* was put in place and trued up from holes *C*, *D* and *B*. As hole *E* is in the center of the plate, it was bored in the engine lathe in the regular way. The pins *F* and *G* were then located. No particular pains were taken with these, as they were under-cut next to the plate; they were then ground on the surface grinder, the plate being stood on edge to get the proper dimension from hole *B*. Next a drill bushing was inserted in the center hole *E* and a plug in hole *B*.

The piece *B*, Fig. 12, having previously been roughed out of tool steel and the center hole having been bored on the

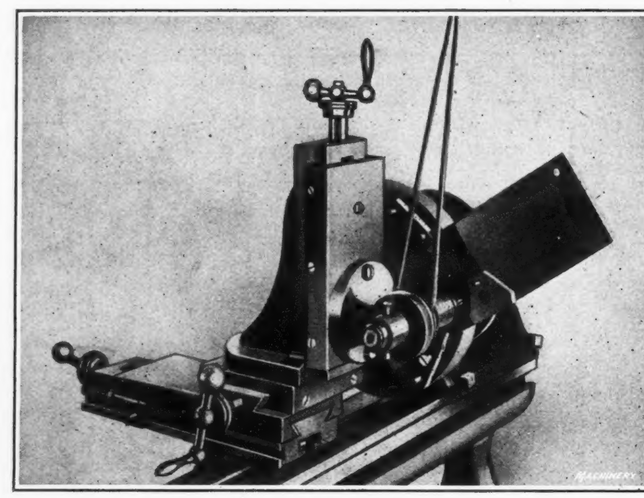


Fig. 14. Milling Edges of Gage and Slots on Master Plate

bench lathe and lapped to a plug fit, was placed over the plug in the hole *B* on the master plate, clamped fast, and the dowel-hole spot-drilled, drilled and reamed through the drill bushing *E*. Next, the four-inch radius was milled, about 0.005 inch being left on a side to be ground off. The milling was done on the bench lathe, as shown by Fig. 14. Plugs were inserted through the work and the holes *E* and *B*, Fig. 15, in the master plate, while another plug was trued up in place in the lathe spindle from which to swing the plate from either of the corner holes *C* or *D*, using the lathe milling attachment as shown. During this operation, the two clearance slots *H* in the master plate were milled so as to allow a grinder wheel to pass over the work on the following operations.

Next the bar *A*, Fig. 12, is milled to receive the piece *B*. This slot is roughed out on the regular milling machine and finished on the bench lathe to within 0.005 inch, using the master plate and the bench lathe milling attachment, as previously described, and locating from the dowel-hole *D*, which has been drilled and reamed, and the two pins *F* and *G*, Fig. 15. Next comes the boring and reaming of the two holes for the pins *C*, Fig. 12. Figs. 16 and 20 show how the part *B*, Fig. 12, is located on an angle-plate over the two pins that

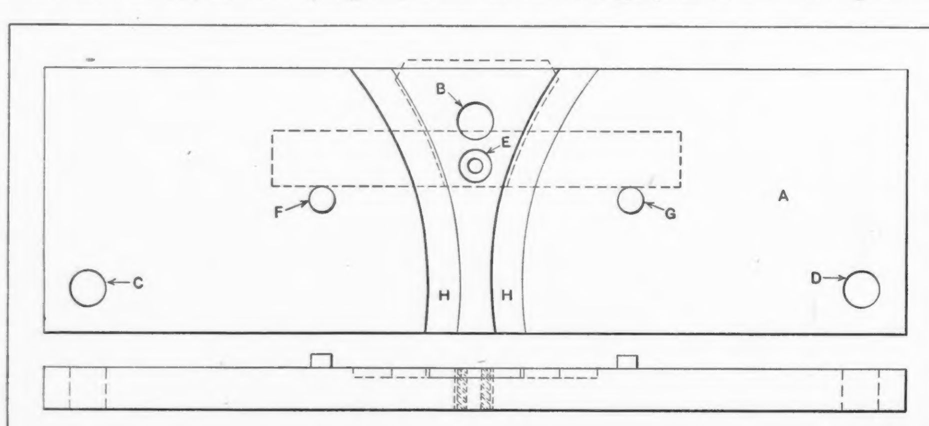


Fig. 15. Master Plate for making Gage shown in Fig. 12

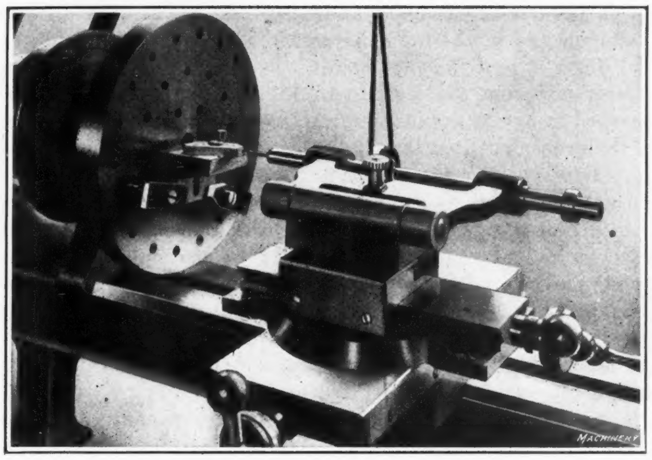


Fig. 16. Lapping Holes in Ends of Gage

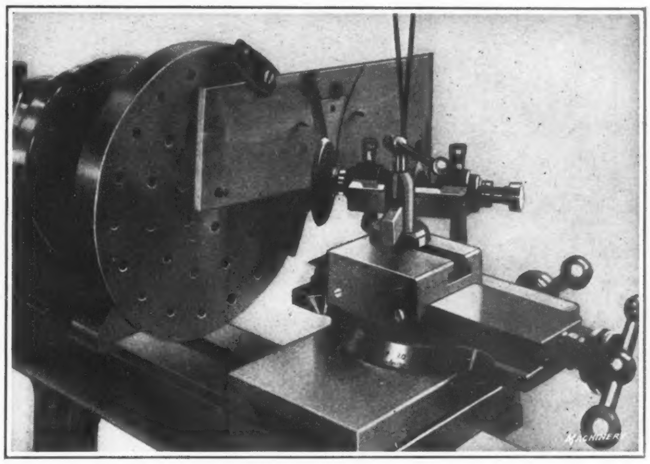


Fig. 17. Grinding Four-inch Radius on Gage

were accurately located for holding the piece in the proper position. After the holes are reamed for the pins, the piece is taken to the milling machine and the end milled where it is to fit on the bar, enough stock being left for grinding after hardening. All the pieces are now ready to harden. After hardening, red-hot tongs are used to draw out those parts that are to be joined together so as to eliminate, as far as possible, any chance of their breaking at this point.

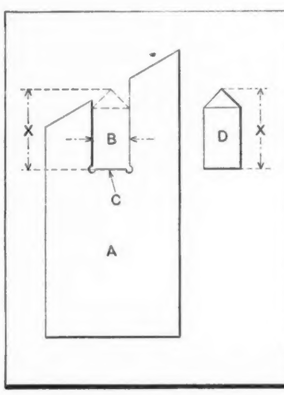


Fig. 18. Master Gage for making Gage shown in Fig. 21

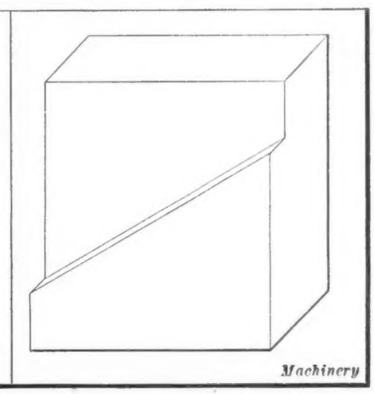


Fig. 19. Master Angle-block for making Master Gage shown in Fig. 18

Next the holes for pins C are lapped out and temporary pins driven in place, after which the work is taken to a surface grinder and the sides ground parallel with these pins. Then the center holes and the dowel-holes are lapped out until the pieces can be put back in place. Fig. 16 shows the final finishing of the two pin-holes with a diamond lap, using the bench lathe traverse spindle grinder. Next the four-inch radius is ground on both parts A and B, Fig. 12. This work is done on the bench lathe, using the master plate swung from the center plug and the tool-post grinder, as is shown in Fig. 17. The lathe is turned back and forth by hand and the measuring is done from the center plug to the side of the radius with a vernier to get the exact radius. Parts A and B are then fitted together and the dowel-holes lapped true with each other and a tight fitting dowel inserted, but not headed over. Getting the dimensions 0.503 and 0.497 inch is then a matter of calculation and measurement from a plug inserted in the center hole in part B to the face of bar A, then removing B and grinding A. After assembling them and inserting and heading the dowel, the gage is finished.

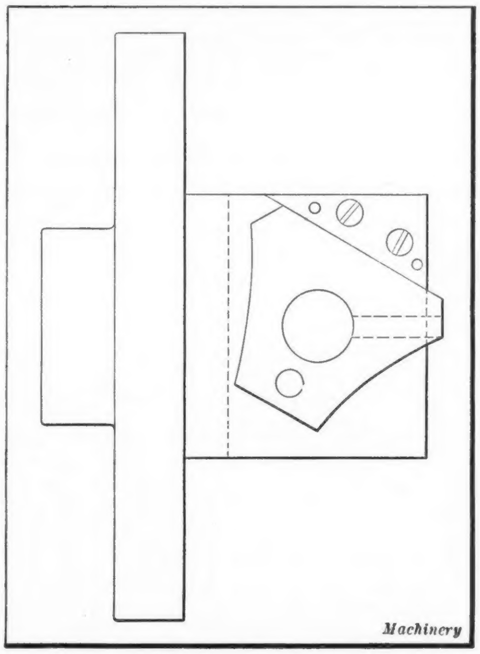


Fig. 20. Holding Gage for boring and lapping Holes in Ends

Flat Gage for Measuring Depth of Slot in Fuse Ring

At A, Fig. 21, is shown a gage that puzzles the average toolmaker. It is a simple flat gage used to measure the depth of a milled slot B in the fuse ring; a is the angle of the edge of the ring, and D and E the dimensions given by the part drawing. The dimension X is determined by calculations involving simple shop trigonometry, but measuring this dimension on the piece is another matter. As it cannot be done directly with micrometers, a master gage A, Fig. 18, must be made. This, at first, seems to be as hard a proposition as the working gage, but actually is much easier. A piece of Brown & Sharpe ground tool steel is roughed out to approximately the shape shown, leaving enough to grind, and is then hardened. It is then placed on a surface grinder, and after the sides and edges, and the surfaces B and C are ground, the angle is ground and dimension X made correct.

But before this can be done, a master angle-block must be made. This block, shown in Fig. 19, is made of machine steel and is ground perfectly square and parallel on the ends and sides. The angle is obtained with the aid of a sine bar and an accurate angle-plate. When this block is finished, the master gage is clamped to it while the angle is ground on a surface grinder. To make dimension X correct, a hardened and ground plug D, Fig. 18, is made, the outside diameter and the point being ground at one setting, so as to have the point exactly concentric. The point is rounded with a fine Arkansas oilstone to remove any slight burr

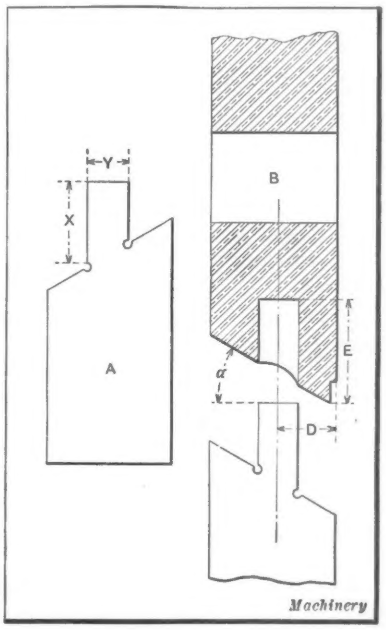


Fig. 21. Flat Gage for measuring Milled Slot in Ring

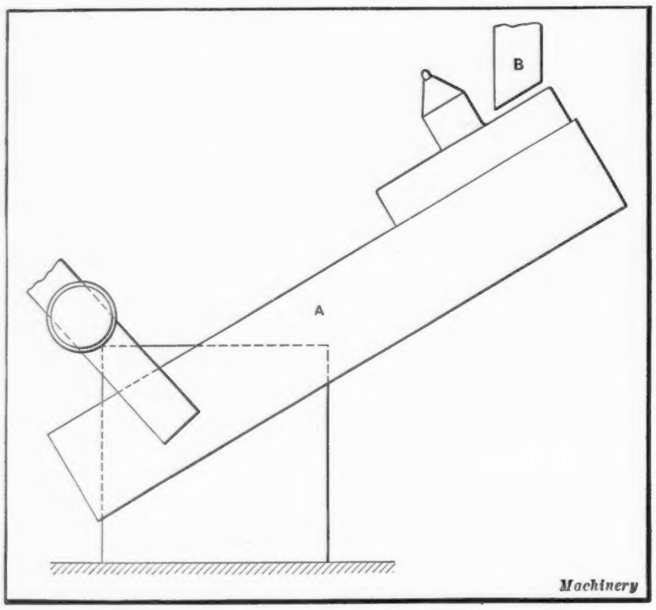


Fig. 22. Using Master Angle-block to get True Angle on Grinding Wheel

or sharpness that can possibly interfere when measuring across it with a micrometer. Care must be taken to remove no more than is necessary. After grinding the outside and the point, the other end is ground, either in the bench lathe or the surface grinder, whichever is most convenient or accurate, until the plug is the proper length. Then the master gage is laid flat on a surface plate and the plug is pressed between sur-

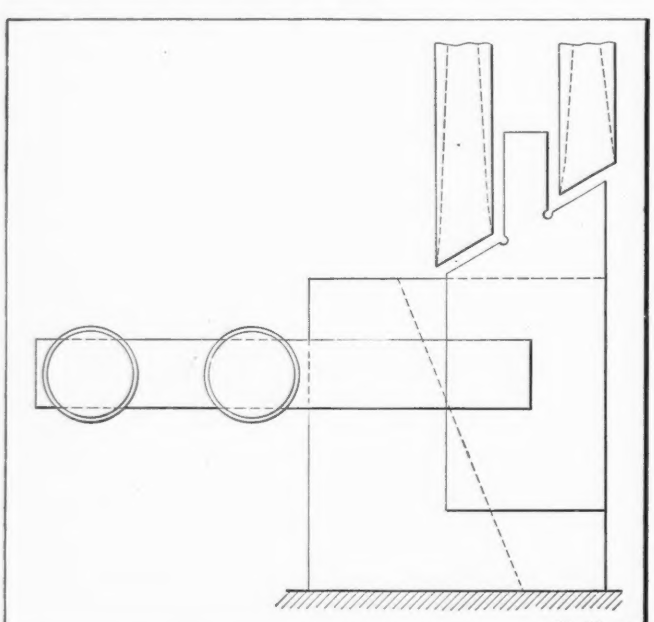


Fig. 23. Method of clamping Gage to Master Angle-block

faces *B* and against surface *C*, as shown by the dotted lines, and secured in that position by a drop of melted wax. This wax is made by melting together one part of beeswax and one part of rosin. When the master gage is secured to it, the master angle-block is taken to the surface grinder and ground on the angle until a straightedge will rest on the angular surface and the point of the plug. Great care must be exercised not to grind off too much, as the point of the plug is so small that a ray of light shining through between it and the straightedge may appear to be several thousandths inch, when in reality it is no more than 0.0001 or 0.0002 inch. After the angle is properly ground, the master gage is ready for use.

The working gages are roughed out of Brown & Sharpe ground stock, no particular pains being taken with them other than to leave enough stock on the working faces to grind, after which they are hardened. They are then ground true and parallel on the sides and edges. In order to grind surfaces *B*, Fig. 18, and the angular faces, the master angle-block is set up on the surface grinder, as in Fig. 22. After a parallel *A* is clamped to it, the diamond emery wheel dresser is slid up and down it past the face of the wheel *B*, thus obtaining the correct angle on the wheel. In Fig. 23, the work is shown clamped to one of the plain surfaces of the master angle-block, in the proper position to grind; the wheel, besides being trued on the face to give the proper angle, is under-cut on the sides with the diamond, as shown by the dotted lines.

In grinding surfaces of this kind, the grinder spindle must have no end play, so it is customary to use a piece of hard wood, sharpened to a blunt point, in the spindle center and keep the spindle in the proper position by lightly pressing against it. If much work of this kind is to be done, a flat spring secured to the wheel guard and pressing against the end of the spindle may be made to answer. After surfaces *B*, Fig. 18, are ground, the angular faces are ground. As these faces must be parallel and perfectly in line, it is difficult to grind them on the surface grinder, so the bench lathe is used.

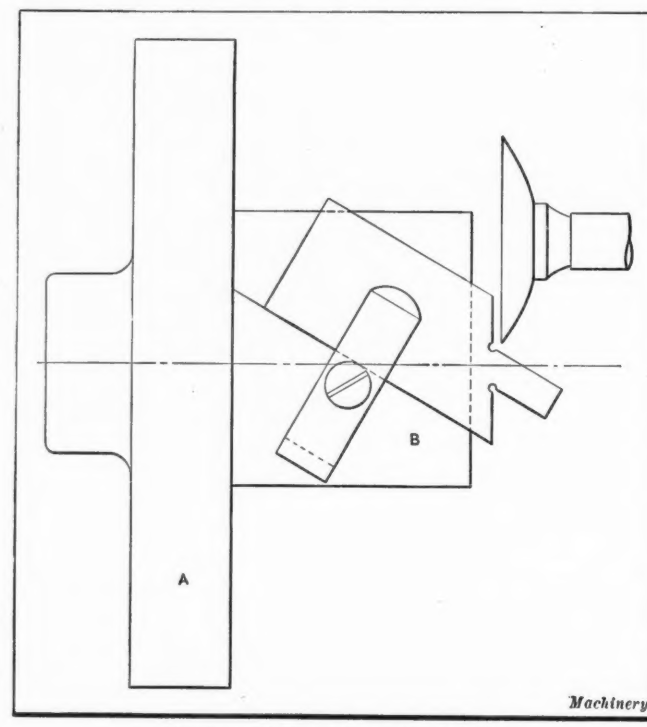


Fig. 24. Grinding Gage in Bench Lathe

In Fig. 24, *A* is the faceplate and *B* is the master angle-block, to which the gage is clamped, which, in turn, is secured to and swung from the faceplate of the lathe. The grinding is done with the bench lathe grinding attachments, either the traverse spindle or toolpost grinder being used. Lastly, the end of the gage has to be ground to make dimension *X*, Fig. 21, correct. This is set up as shown in Fig. 23, only using a straight wheel and trying the work with the master gage.

Gage for Testing Counterbore of Angular Hole in Fuse Body

Fig. 25 shows a gage for testing the depth of counterbore of the angular hole *A* in the fuse body, Fig. 3. This consists of the body into which pins are driven. All the parts are of tool steel and are hardened and ground. The hole through the center provides means for driving out the pins easily. The difficulties

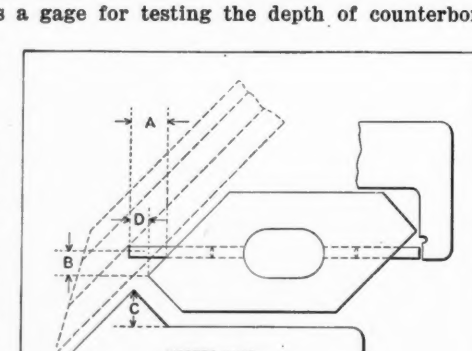


Fig. 25. Gage for Depth of Counterbore of Angular Hole in Fuse Body

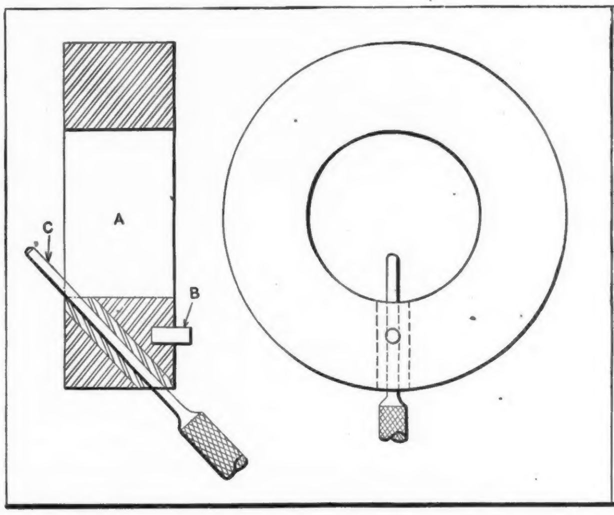


Fig. 26. Gage for locating Angular Hole drilled in Stem of Fuse Body

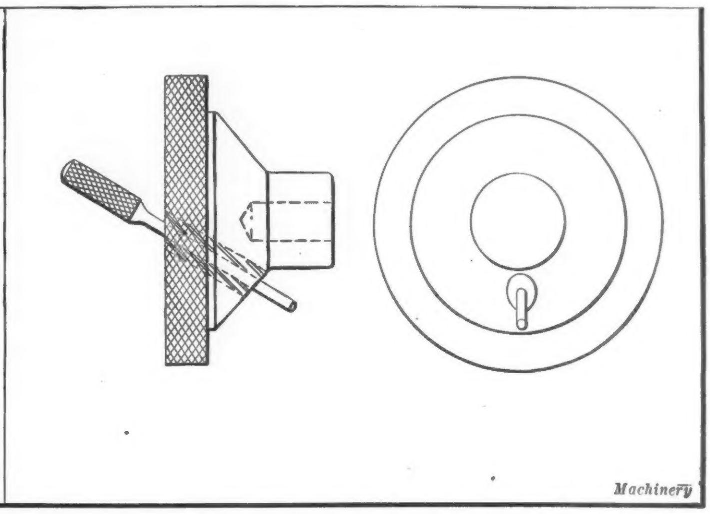


Fig. 27. Gage for locating Angular Hole, Similar to that shown in Fig. 26

met in making a gage of this type are in getting the dimensions *A* and *B* correct, as neither of these may be obtained direct with ordinary measuring tools.

The method of making these gages is as follows: First the body is roughed out, taking care only to see that the two pins are kept in line with each other. Then the body is hardened, the holes lapped out to receive the pins, the pins put in temporarily, and the sides and edges ground parallel with these, care being taken that both the edges are a given distance from the pins. The pins are then removed and the work is clamped to a master angle-block and the longer of the two oblique sides ground.

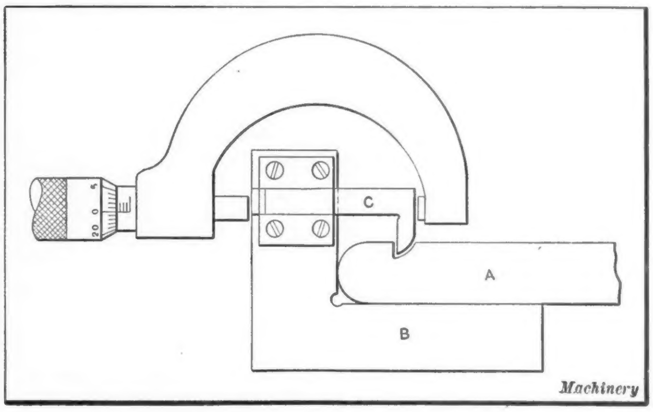


Fig. 28. Testing Slot in Relation to Radius

Before finishing the short sides and getting dimension *B*, it is necessary to make up the master gage, which may be used to test the working gages. The angles on this master gage are generated by a sine bar and an accurate angle-plate, grinding them on a surface grinder. The measurement *C*, which is the difference between *B* and the edge of the working gage, is easily obtained with a micrometer. The "Go" and "Not Go" ends of the master gage, which are used to test the length of the pins, are ground in the usual way, as they can be measured direct with the micrometer.

When the short oblique side of the working gage is to be ground, the gage is clamped fast to a master angle-block, set up on the magnetic chuck of a surface grinder and ground little by little. The master gage and a knife-edge straightedge are then used to test it, as shown, until the two edges are perfectly in line. A variation of 0.0002 inch between the master and the gage will look large when they are held to the light. After finishing the angle, which makes

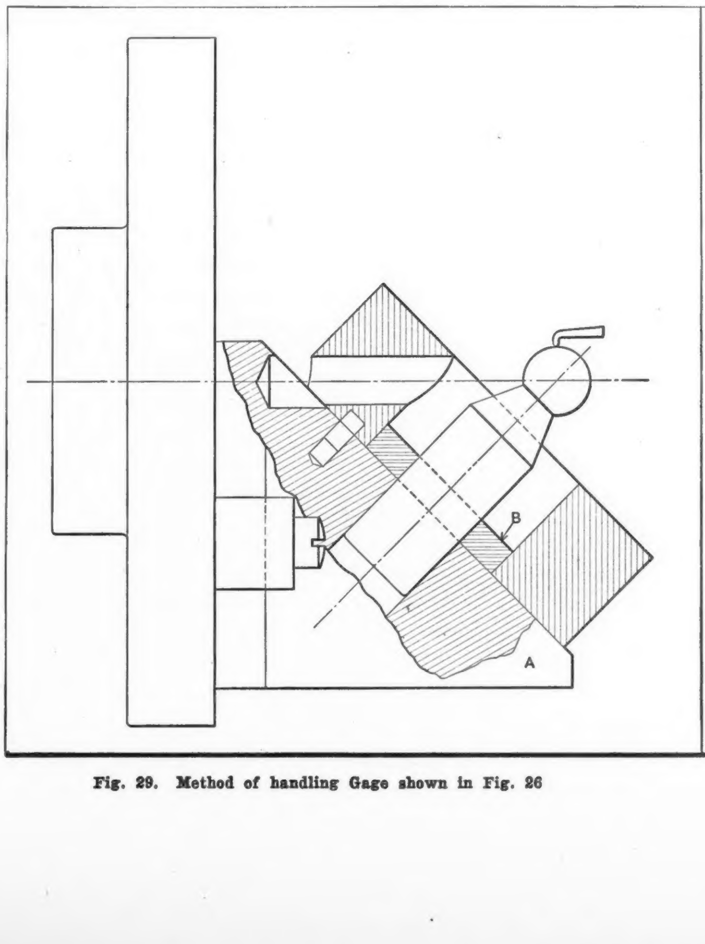


Fig. 29. Method of handling Gage shown in Fig. 26

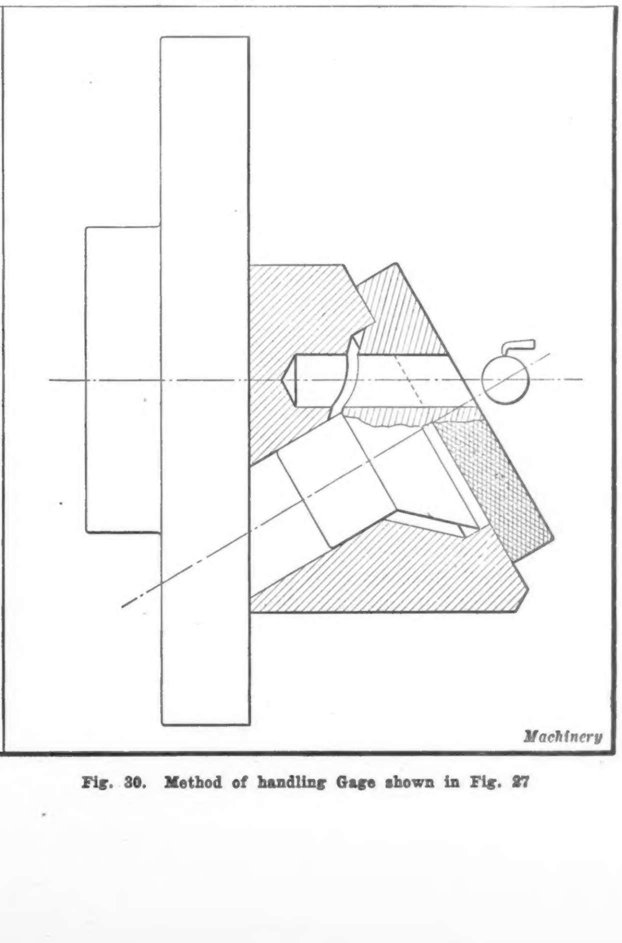


Fig. 30. Method of handling Gage shown in Fig. 27

dimension B correct, the hardened pins are driven in, leaving just enough projecting to grind. Then, squaring up on an angle-plate, the pins are ground off, the master gage being used to get the dimension D, which has been found, by trigonometry, to bring dimension A right and finish the gage.

Testing Slot in Relation to Radius

Fig. 28 shows a method of measuring a slot in relation to a radius that it is desired to make more accurate than can be done with a height gage or other ordinary means. A is the piece to be measured; B, a special square of hardened and ground steel; C, a smaller square made to fit and slide perfectly in a slot in the larger square and held in place by a flat plate screwed on, as shown. All parts of the tool are made as accurately as possible. The manner of using is clearly shown; the width of the square ends are subtracted from the over-all dimension found by the aid of the micrometer.

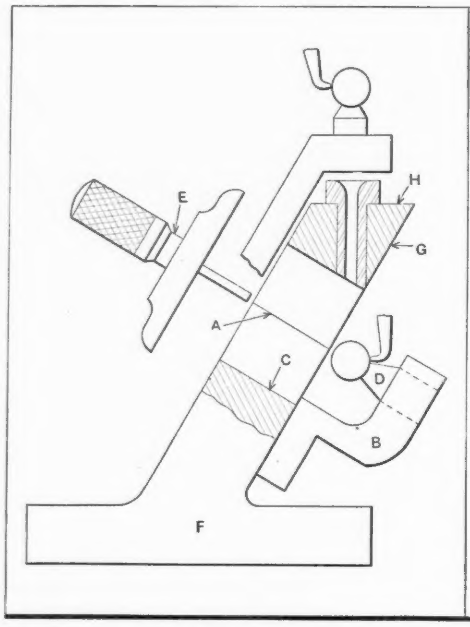


Fig. 31. Jig for drilling Angular Hole in Stem of Fuse Body

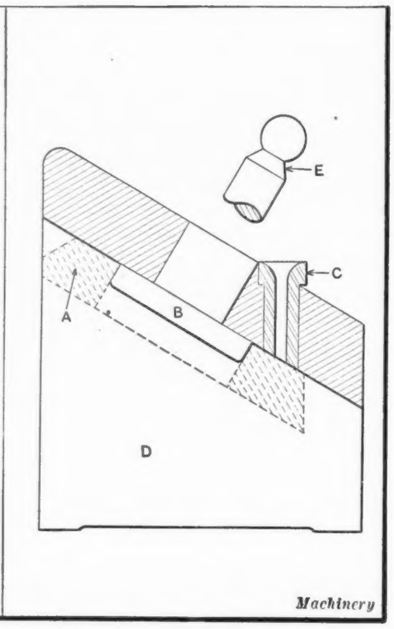


Fig. 32. Jig for drilling Angular Hole in Fuse Ring

Miscellaneous Examples of Gages and Jigs

Figs. 26, 27 and 29 to 32, show other examples of gage and jig work. Fig. 26 shows a ring A that fits over the stem of the fuse body and down onto the platform, where it is located from the pin B that fits into a hole in the platform. The pin C is used to gage the location of an angular hole drilled through the stem. The method of handling this gage is as follows: After roughing out the ring A, allowing for grinding and locating the pin B, it is transferred to a master angle-plate A, Fig. 29, which, in turn, is clamped to a bench lathe faceplate, as illustrated. This angle-plate has been previously ground perfectly true on the surface grinder, using a sine bar to make the angles correct; it also has two holes accurately located in it, one for centering the gage and the other for receiving pin B. When the angle-plate has been properly positioned on the lathe faceplate by means of the ball plug, as shown, the latter is removed and another plug inserted; over this plug is placed a ring B that is used to locate the gage. The remainder of the work is performed as has been previously described.

Fig. 27 shows a somewhat similar gage, while Fig. 30 shows the method of handling it on a master angle-plate, using a ball plug as described for the other gages. In all cases, due allowance must be made for grinding all over after hardening and repeating all operations on surfaces that are to be very accurate.

Fig. 31 illustrates a jig for drilling an angular hole in the stem of the fuse body, this being the hole for which the gage shown in Fig. 26 is used. This jig was made in two pieces, being split on center line A on account of trouble experienced from drill breakage. When solid jigs were used and drills broke, they wedged the body fast in the jig and it was difficult to remove them; but by making the jig in two pieces, the upper part can be removed, and the drill easily extracted without removing the jig proper from the drill-press table.

The method of handling this jig is to fasten an angle-iron B to the back side of the jig, then set it up in a lathe, or milling machine, and finish-bore the hole C. At the same setting, angle-iron B is bored to take the ball plug D, thus having the ball plug exactly central. The ball is easily set to the exact apex of the angle by using the depth micrometer E from the face of the jig. After the ball is set, the jig is swung up on a lathe faceplate from the surface F, the top half of the jig is removed, so that the ball can be reached by an indicator, and the ball indicated until it runs true. The top half of jig G is then put back and bored, reamed, etc., in the regular way.

If the jig had not been made in two pieces, the setting could have been accomplished by locating the ball as already described and then using a second ball fastened to a piece as shown at the top of the view, and transferring the location by means of an indicator, height gage or other means. Another method is to locate a jig button on face H, using the ball for transferring the location.

Fig. 32 shows a drill jig for drilling an angular hole in a time-fuse ring. The ring A is located over the plug B, which, with the drill bushing C, is driven into the jig body D. The manner of using the ball plug E at the apex of the angle is clearly shown.

* * *

RHOTANIUM—A PLATINUM SUBSTITUTE

Rhotanium, a palladium-gold alloy in which the gold content varies from 60 to 90 per cent, is said to form a satisfactory substitute for platinum. It is malleable and ductile and can be welded without the use of a flux or other reagent. Its specific gravity ranges from about 16 to 18.5, according to composition, and its losses by volatilization at temperatures below 1300 degrees C. are less than those of commercial platinum. It can be used, within its temperature limitations, in electric heating units, and is satisfactory for contact terminals in many forms of automatic electric devices. Its behavior when tested on certain magnetos was satisfactory, but experiments performed on a high-grade aeroplane-engine magneto gave negative results. It is not suitable for use with hot concentrated nitric acid nor for electrolytic anodes, but for all other chemical purposes it is entirely satisfactory if the proper composition is chosen and if properly manufactured. Certain of the alloys have given good service in dentistry when used for pins and baked into porcelain teeth and as thin foil and heavy sheet for other types of construction. Rhotanium is said to be superior to pure platinum for use in jewelry; it is harder, stronger and takes a better finish. It does not tarnish, is noncorrodible, has practically the color of platinum, and can be worked as readily. Jewelry made with it passes the common jewelers' and platinum buyers' tests.—*U. S. Commerce Reports.*

* * *

Sir Francis Fox told the Royal Geographical Society, of Great Britain, that one of the difficulties in planning the actual route of the Channel tunnel was to keep the tunnel well within the thickness of the gray chalk. Because of this the tunnel would not be quite a "bee line." The maximum depth of water over the tunnel would be from 160 to 180 feet, and the roof of chalk over the structure had been fixed at a minimum of 100 feet. A dip in the level of the rails would form a water lock, so that a mile of the tunnel could, in case of emergency, be filled with water. The mechanism for doing this would be controlled from Dover Castle, and the entrance and exit of both tunnels would be under the gunfire of the Dover forts. By means of the tunnel, it was stated trains would run direct from London to Paris in less than six hours, and it would be possible to go from London to Constantinople, Petrograd, and by the Serbian express to the Far East.

LETTERS ON PRACTICAL SUBJECTS

We pay only for articles published exclusively in MACHINERY

DETERMINATION OF BLANK DIAMETER FOR DRAWN METAL SHELL

In some shops, the determination of the diameter of the blank for a shell of given diameter and depth is a matter of guess or "cut and try," although there are tables that give this information. However, all the tables that the writer has seen have been made by calculating the blank diameters for various sized shells by the formula $D = \sqrt{d^2 + 4dh}$, in which D is the diameter of a blank for a shell having a diameter d and a height h. It is obvious that the area of the blank must be equal to the area of a circle having a diameter d and the lateral area of the shell. Then, as the area of the circle with a diameter d is $\frac{\pi d^2}{4}$, the lateral area is πdh, and the blank area is $\frac{\pi D^2}{4}$;

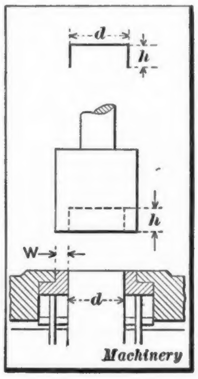


Fig. 1. Shell and Blank-holder

$$\frac{\pi D^2}{4} = \frac{\pi d^2}{4} + \pi dh,\ D^2 = \frac{4}{\pi}\left(\frac{\pi d^2}{4} + \pi dh\right),\ D = \sqrt{d^2 + 4dh}.$$

But this formula does not take into consideration the "draw," or stretch, of the metal that takes place during the stamping operation. This draw is in proportion to the depth of the shell and is different for different metals. To determine the blank diameter for a zinc shell of known depth and diameter, made in one drawing operation, the chart shown in Fig. 2 will be found accurate. This chart is made with each division representing 1/64 inch. The abscissas represent the depth h of the shell, Fig. 1, and the ordinates, the width W of the blank-holder. For example, suppose that it is desired to find the blank diameter of a shell 2 inches in diameter and 13/16 inch deep. Now 13/16 inch is 52/64, so following the vertical line from 52 to the curve and reading the horizontal line that it intersects at that point, the width W of the blank-holder is found to be 39/64 inch. $39/64 \times 2 = 1\ 7/32$, which, added to the diameter 2 inches, gives a blank diameter of 3 7/32 inches.

Wheeling, W. Va. H. S. BRADY

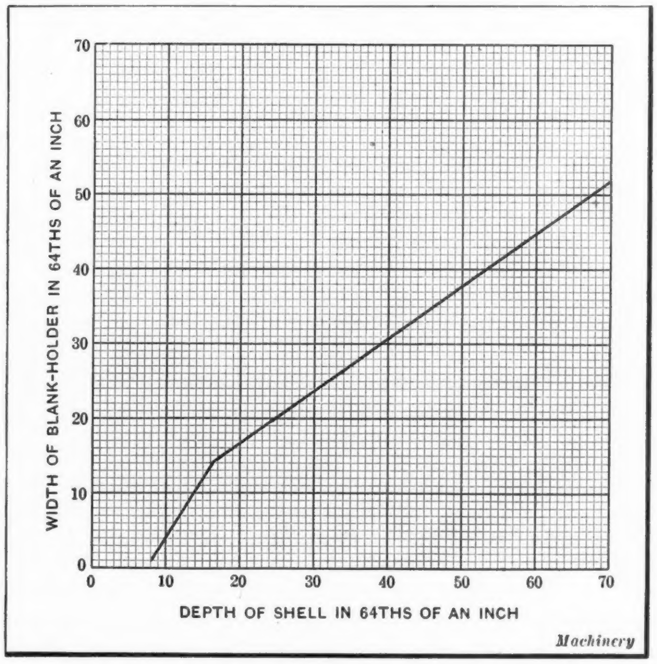
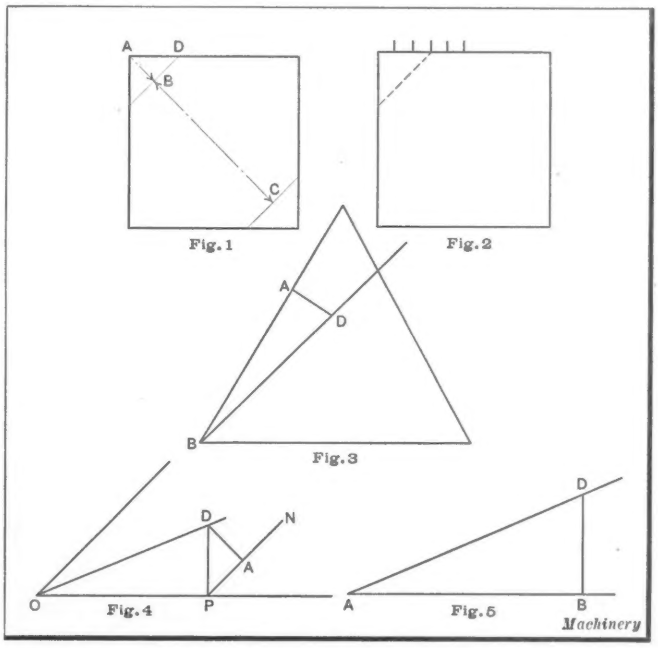


Fig. 2. Chart for determining Blank Diameter of Zinc Shell

MAKING SQUARE STOCK OCTAGONAL

In the machine shop, if a piece of square stock is to be made octagonal, it is necessary to know either the depth of cut AB, Fig. 1, or the thickness BC of the collars between the straddle-mills. To the carpenter, however, the problem presents itself in a different light. He cares for neither of these measurements, but needs AD, so that he can scribe a line to guide his saw and plane.

The methods employed to obtain this dimension are interesting. Some of the men with whom the writer has conversed say that they take AD equal to one-third the side of the square, and "don't cut quite to the line." This is undeniably an easy scheme, but about as accurate as the proverbial "blacksmith's hairbreadth," the actual value of AD being not side $\times$ 1/3, but side $\times$ 0.2929 +. Others adopt the plan, shown in Fig. 2, of dividing half the side of the square into fifths and taking the third division from the corner as the starting point for scribing the line. This is not so inaccurate a method as the first, 0.3 being, probably, near enough to 0.2929 + for woodworking purposes, except in the more exacting branches of work.



Figs. 1 to 5. Diagrams showing Methods used in making Square Stock Octagonal

Another plan is to lay out an equilateral triangle, as in Fig. 3, then with the miter square subtract 45 degrees from it. The length of the side of the square is then laid off at BA, and the perpendicular AD erected, its length being taken for AD in Fig. 1. This, also, is only an approximation, giving side $\times$ 0.2588 +. Some workmen, however, follow a method that is theoretically exact, as it gives the true value: AD = side $\times$ tan 22 deg., 30 min., $\times$ sin 45 degrees. Laying out an angle of 45 degrees with his miter square, the workman bisects it with dividers and straightedge, as in Fig. 4. Then making OP equal to the side of the square, he erects the perpendicular PD, which equals side $\times$ tan 22 deg., 30 min., and

drawing *NP* at 45 degrees to *PD*, he draws the perpendicular *AD*, which he takes for *AD* in Fig. 1.

Various other methods of obtaining *AD* by construction are in use, but none, so far as the writer is aware, is as quick as the approximate schemes here given, nor as accurate as that given in Fig. 4. Obviously, the 22-degree, 30-minute angle can be used in the solution of two problems allied to this; for if, in Fig. 5, *AD* is made equal to the diameter of a circular piece, *BD* will be the side of the included regular octagon. Conversely, if *BD* is made equal to the side of the octagon desired, *AD* will be the diameter of the circumscribing circle.

New London, N. H. GUY H. GARDNER

BLANKING AND FOLDING PUNCHES AND DIES

The shell shown at *A*, Fig. 1, is made, in two operations, from 16-gage hot-rolled steel. At *B*, it is shown seated in position, and as it is surrounded by metal, it will not open if an unequal strain should develop. This shell is utilized as a spring seat and retainer; but it has a wider scope of usefulness by reason of its low cost of production. Under ordinary conditions, a shell of these dimensions drawn from a round blank will take five press operations; or, on a basis of 8000 pieces a day, 40,000 operations are required, against 16,000 operations by the folding method. In addition, five separate dies and punches are required, besides the expense of repairs and extra help. Furthermore, uniform and unstrained walls cannot be guaranteed when dies and punches must often be polished to eliminate the excessive friction caused by the constant rubbing of metal and dies.

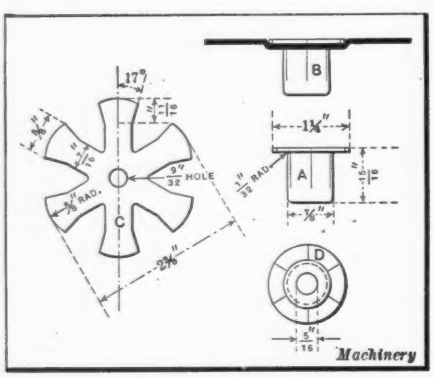


Fig. 1. Blank and Shell formed from it

The shell *A*, Fig. 1, is made on an inclined press in one blanking and one folding, or drawing, operation. The blanking is done with the compound punch and die shown in Fig. 2. The advantage of operating this die in an inclined press is that the blanks will drop clear of the die, by gravity, and will be transferred to a receptacle by a chute fastened to the stripper at *J*. The blank *C*, Fig. 1, which is made of scrap,

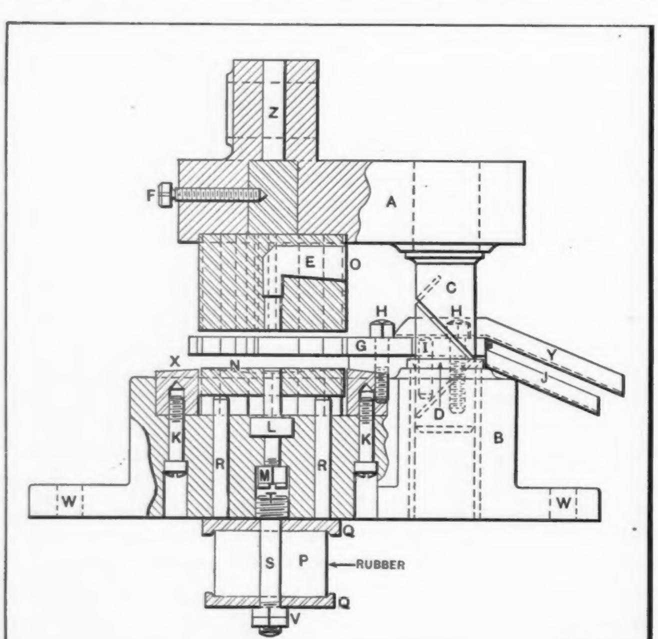


Fig. 2. Blanking Punch and Die

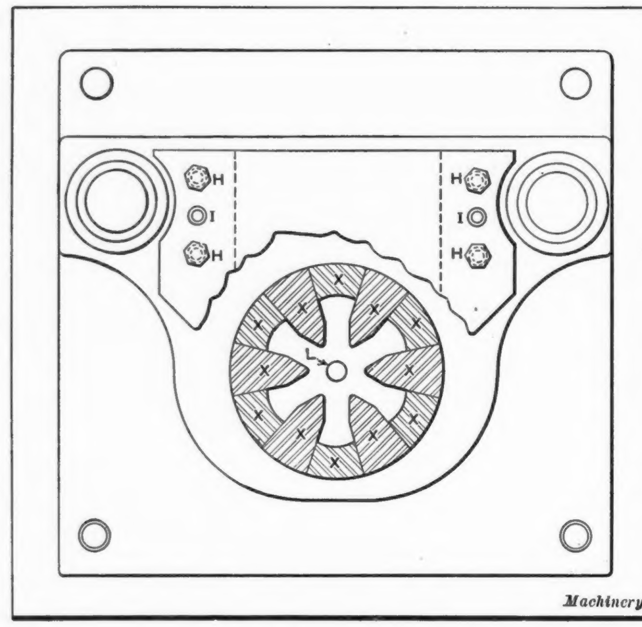


Fig. 3. Top View of Blanking Die

must be carefully developed in size and shape to meet the necessary requirements in dimensions and have all seams tight, as well as to have a uniform and concentric flange, as shown at *D*, which is a view of the bottom of the shell. This view shows that the hole has opened 1/32 inch in drawing, which is always taken into consideration in developing work of this nature.

Fig. 2 shows the compound blanking and perforating die, which is of the pillar type; this is easily set up, adjusted, and

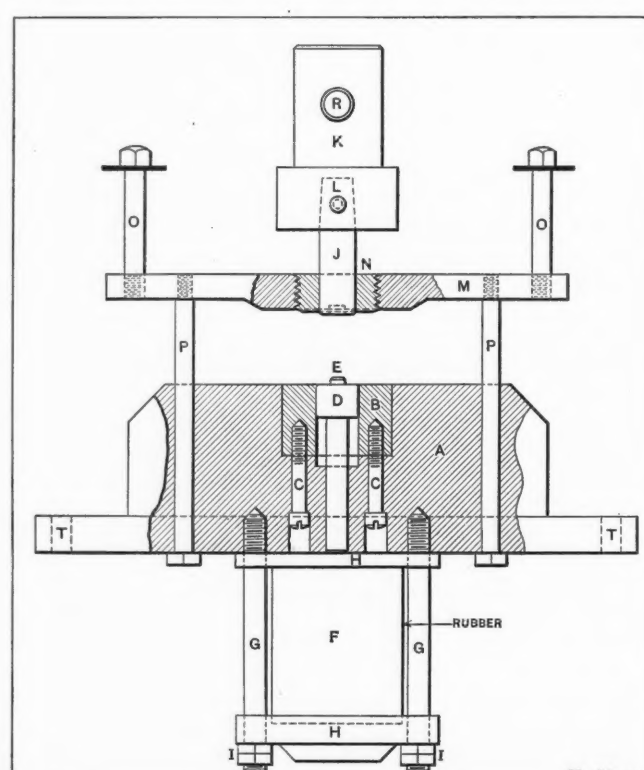


Fig. 4. Folding Punch and Die

put into operation. *A* is the cast-iron punch-shoe, made to fit the press ram; *B* is the die-shoe, also made of cast iron. These are held in alignment by guide pins *C* and bushings *D*, which are made of tool steel and are hardened and ground. The guide pins *C* are provided with oil channels to facilitate lubrication; the lubricant used consists of white lead and oil. The punch *E* is made of hardened tool steel and is held in position by a set-screw *F*. The hole *Z* is provided to remove the punch *E*, when it becomes necessary. Punch *E* has a clearance hole at *O* and when operating in an inclined press dis-

charges the slugs over the stripper G, which allows them to slide through a chute Y to the scrap receptacle. The stripper G is held in position by screws H and dowel-pins I.

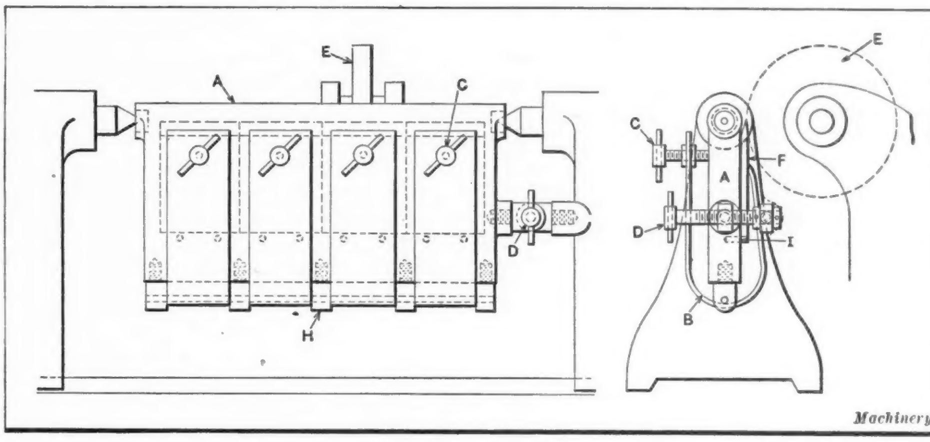
The die X is made, in sections, of tool steel and is hardened. It is securely held in the die-shoe B by reason of the sections being properly fitted and by screws K. Fig. 3 shows a top view of the die, which consists of twelve sections X; it also shows the clearance under the stripper to allow the blank to leave the die and enter the chute J, Fig. 2. The perforating punch L is seated in the bottom of the die and is held in position by nut M. The ejecting pad N receives its motion from a rubber buffer P, the force being transmitted through plates Q and pins R. The rubber buffer is held in position by a bolt S screwed into the die-shoe at T and tension nuts V. Holes W are provided for bolting the die to the press, making it unnecessary to use a bolster plate.

Fig. 4 shows the folding, or drawing, punch and die. The die-shoe A is made of cast iron and has a seating bushing B, held in position by screws C. Bushing B is made unusually long to increase its life; after the face is ground when the edge becomes worn, a washer is placed under the bushing to raise it to the proper height. This bushing is tapered 0.003 inch to allow the shell to be ejected more easily by the knockout pin D. Pin D has a gage pin E on its face to gage and center the blank previous to drawing it. The knockout pin receives the proper tension from a rubber buffer F, which is secured by bolts G, plate H, and adjusting nuts I.

The drawing punch J is made of carbon steel and is counterbored to clear the gage pin E. It is held in a machine-steel punch-holder K and secured by a tapered pin L. The stripper plate M is machine steel and has a hardened bushing N in the center to flatten the flange of the shell when the punch descends. This bushing also releases the shell from the punch when the latter returns to high center. The adjustment of the stripper M is made by bolts O and P. A pin R secures the punch to the ram and prevents it from pulling out under ordinary conditions. Bolt holes T are provided for securing the die to the bed of the press.

Highland Park, Mich. ERNEST A. WALTERS

KNIFE GRINDING FIXTURE



Knife Grinding Fixture

When their edges are to be ground, knives, bayonets or other thin stock may be set up on the centers of a Brown & Sharpe grinding machine or some similar type of grinder. The grinding fixture here shown consists of a cast-iron body A, to which spring-steel plates B are attached by pivots H. These plates are U-shaped and clamp the work F to the cast-iron body A, the tension being adjusted by screws C. The centers are provided with two hardened bushings, which engage the centers of the grinder. The fixture can be set at any desired angle by adjusting screw D. This screw works in pivots, one of which is screwed into the fixture and can rotate to suit the various angles required. The other pivot is screwed into the tailstock in the same way, and is not threaded in the hole. The adjusting screw has two collars, one on each side of the pivot. Stops I support the work while it is being ground by wheel E, which can be adjusted backward and forward. This fixture has proved to be very rapid and efficient.

Mount Vernon, N. Y. S. W. POTTS

COATING CASTINGS WITH CHALK

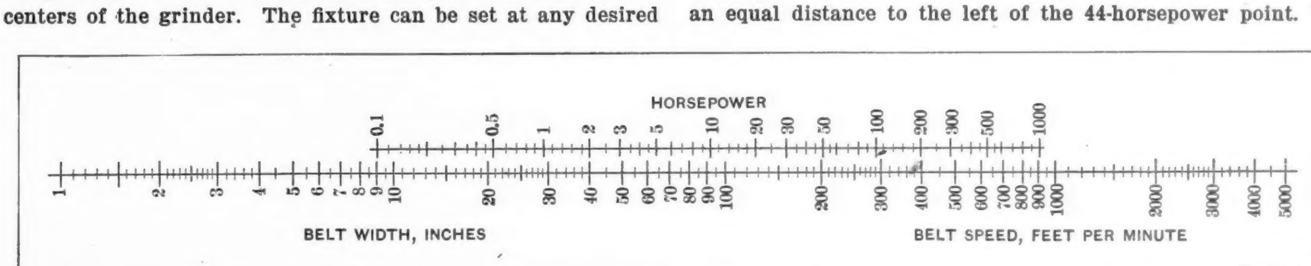
Common white chalk is used extensively as a coating on castings that are to be laid out. Although its application may seem to be extremely simple, some men cannot get the chalk to stay on even if they rub a whole lump into dust and blow it off. The first time over, the chalk sticks fairly well, but the coating is not heavy enough for lines drawn upon it to be easily distinguished; after that the pulverizing begins. Rubbing in this pulverized chalk with the fingers will give a good white face, and one that will stand scribing. When a vigorous rubbing will not make the chalk stay, the old schoolboy trick of wetting it will help. Momentarily, the dampened surface looks too gray or black, but blowing on it drys it to its normal white. If a machined cast-iron surface is to be laid out, chalk should only be used when permission has been obtained, as the chalked section is sure to rust—not badly, but enough for it always to be visible unless a cut is taken over it.

Middletown, N. Y. DONALD A. HAMPSON

CHART FOR POWER TRANSMITTED BY LEATHER BELTS

The accompanying chart may be used to determine the width of a single leather belt necessary to transmit any ordinary amount of power, the horsepower that will be transmitted by a single belt running at a given speed, or the speed at which a belt must run in order to transmit a given power. For example, to determine the power that will be transmitted by a single belt 7 inches wide running at a speed of 5000 feet per minute, locate the points 7 and 5000 in the lower graduated line and then find the point midway between them. This point will be found at 44 horsepower on the upper graduated line. The dividing may be done with a rule, or a pair of dividers, or by folding a piece of paper.

Should it be necessary to transmit 44 horsepower by means of a belt traveling at a speed of 5000 feet per minute, the width of single belt required may be found by measuring the distance between 44 horsepower and 5000 and then measuring an equal distance to the left of the 44-horsepower point. In

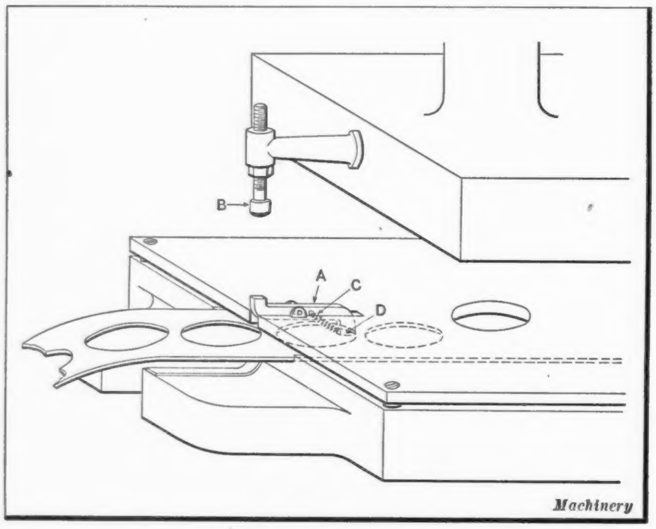


Power transmitted by Leather Belts

this case, it will be found that a 7-inch belt is sufficient. In a similar way, the belt speed can be determined where the belt width and horsepower are known. This chart is based on the well-known rule of thumb: A single leather belt, one inch wide, running at a speed of 800 feet per minute will transmit one horsepower. N. G. NEAR

AUTOMATIC STOP FOR BLANKING DIES

Probably one of the most valuable attachments used in connection with blanking, shearing and perforating dies, where stock is fed in by hand, is the automatic stop, and yet it is astonishing how little is known of its application. When the stock is fed in a strip or from a reel, this simple contrivance is more efficient than any kind of automatic feed and is far less expensive. The writer has observed many instances where the automatic stop could have been applied with a great saving of time. In one case the production of mica and hard rubber disks was increased from 11,000 to 100,000 a day by its use, while a shop blanking 8000 sheet-steel gear blanks increased its daily output to 58,000. The stop is an essential feature on dies made by high-class diemakers and is extensively used by firms who specialize in punch-press products, but there is no reason why firms who use the punch press as auxiliary equipment should not adopt its use wherever possible.



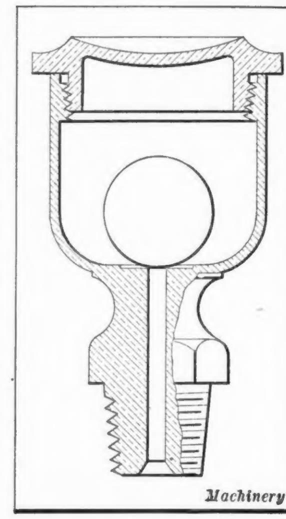
Automatic Stop for Blanking Dies

The illustration shows the application of this stop to a simple blanking die. Trigger *A* is shown locating the stock for the next blank, one of the perforations in the stock serving as a shoulder for this trigger at point *D*. When the ram descends, stud *B* trips the trigger *A*, lifting its point *D* until it clears the stock. When the point clears the top of the flat stock, the spring *C* pulls the trigger forward; and when the stock is fed farther, the spring pulls the trigger down into the next perforation, which again forms the shoulder for the point. One end of spring *C* is fastened to trigger *A* and the other to the bottom of the stripper plate. There is a slot in the trigger for the fulcrum pin, which allows the double motion, forward and down. This entire operation is repeated at each stroke, so that the press may be run at full speed and the stock fed through without having to trip the press each time. The trigger is shown mounted on two lugs on top of the stripper plate, but it may be set in the die-block beside the stock, reaching in over the stock. While only a simple case is described here, the application of the automatic stop will not at any time be found complicated.

Cincinnati, Ohio JOSEPH AHLERS, JR.

IMPROVED FORM OF OIL-CUP

On a number of small machines an ordinary brass oil-cup with a top that is screwed on is used. Waste soaked in oil or boiled in vaseline before soaking is then put in it. If the spindle revolves very rapidly a vacuum is formed in the cup, causing a thread of the waste to be drawn into the bearing. On most of the smaller grinders and buffing lathes, the bearings are of babbitt, and so are quickly cut enough to allow dirt to gather and in time to wear the spindle, thus spoiling the efficiency of the entire machine.



Improved Form of Oil-cup

This trouble is eliminated in the oil-cup shown in the accompanying illustration. A basin about the diameter of the ball used is milled in the brass cup. Then the steady, positive vibration of a grinding or a buffing machine causes the ball to rock on the oil-hole, thus allowing the oil to drop, as in a sight-feed oiler. The ball also shuts off the supply of oil when the machine is not running. The fact that more oil can be put in at a time means that the machine will run longer without the trouble of oiling and an operator can readily tell if oil is needed by removing the cap. The steel ball used should be six times the diameter of the hole in the oil-cup.

New Britain, Conn. JOHN J. MCGAULEY

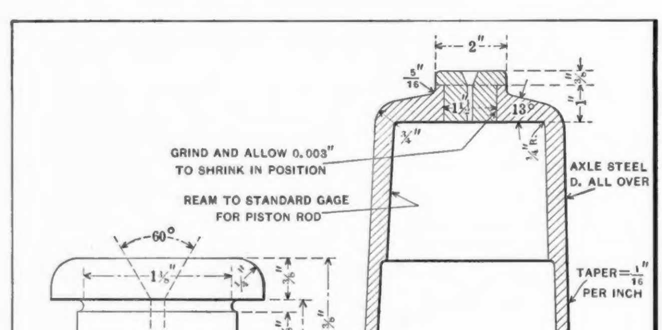
REDUCING GLARE OF ELECTRIC BULB

Coating an electric-light bulb with Prussian blue reduces the glare and gives a light that does not tire the eyes. The pigment should be rubbed lengthwise on the bulb, but not on the bottom, of course.

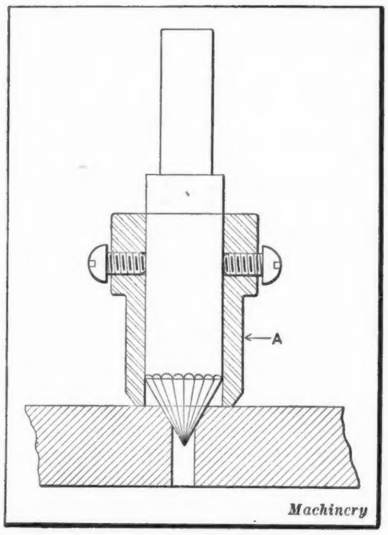
Milwaukee, Wis. FRED FRUHNER

CENTERING SLEEVE FOR PISTON-ROD

The device shown in the accompanying illustration was designed principally for use on piston-rods that have to be trued up in a lathe or grinding machine, but the centers of which are so battered that they will not run anywhere nearly true. So much material must be cut or ground off a piston-rod in this condition that the rod soon gets down to the limit size, and instead of having a long and useful life it is wasted. For use under these conditions, a sleeve is made to fit the end of the piston-rod. In one end of this a small, hardened, tool-steel plug is shrunk. This plug has a 1/8-inch hole and is countersunk 60 degrees to suit the lathe center. At the other end, the sleeve is made a little larger in section, so that it can be knocked off the piston-rod with a soft hammer, when the rod has been turned or ground, without being injured. This sleeve can be modified, of course, to suit other tapered or straight pieces with poor centers. M. K.



Sleeve for truing up Piston-rods with Damaged Centers



Countersink with Sleeve attached for obtaining Accurate Depths

COUNTERSINK SLEEVE

The sleeve here shown enables the user to obtain accurate depths in countersinking; where a large quantity of work is to be machined to the same depth, it saves time and produces satisfactory results. The sleeve *A* is made to fit the countersink and may be adjusted to suit the piece being worked on. The tool is fed down until the sleeve touches the surface of the work, so that all the pieces are countersunk to the same depth. It is difficult to countersink all the pieces alike without employing some method of this kind, especially if some of the pieces are thicker than others, but this is successfully accomplished with the tool described.

Ambridge, Pa. AUGUST J. LEJEUNE

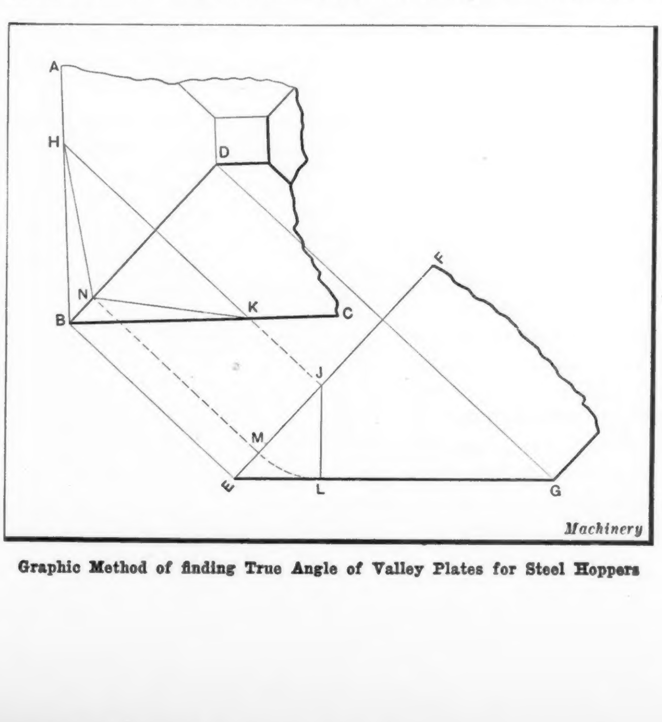
FALSE GRAPHIC REPRESENTATION

I find Babson's "Graphic Representations of Volumes and Weights" to be misleading. For eight times the quantity, he shows a bottle, bag, or barrel eight times as high and wide; whereas it should be only twice the linear dimensions, because $8 = 2 \times 2 \times 2$. This method was carried to the height of ridiculousness in the war statistics of the National Security League and American Defense Society, where armies were represented by soldiers of height in proportion to number. Nothing is so simple and convincing as ordinary heavy straight lines to scale.

New York City ROBERT GRIMSHAW

FINDING TRUE ANGLE OF VALLEY PLATES FOR STEEL HOPPERS

The article in the May number of MACHINERY, "Laying Out a Hopper Miter Joint," brings to mind a method the writer has used to find the true angle of valley plates used on steel hoppers. It is a graphic method and may be used for any size or shape of hopper. Let *ABCD* represent the plan of the hopper, while *EFG* is the elevation; *BD* is the intersection line of the sides. Draw *HK* perpendicular to *BD*; line *HK* is the edge of an imaginary plane passed perpendicular to the intersection line and is shown in the elevation by a line *JL* drawn perpendicular to *EG*. Revolve *JL* about the point *J* to the position *JM* and project the point *M* back to the plan to *N*. Then *HNK* is the true angle of intersection of the two sides of the hopper, since it is the trace on a perpendicular plane of the two sides after the plane is revolved into the plane of the drawing.



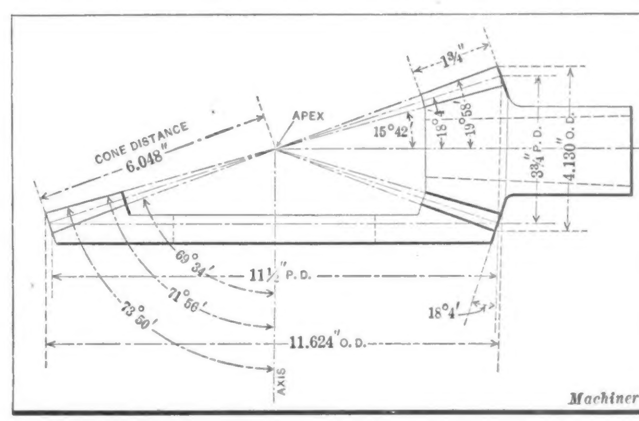
Graphic Method of finding True Angle of Valley Plates for Steel Hoppers

St. Joseph, Mo. L. M. HAMLET

STUB-TOOTH BEVEL GEARING

Stub-tooth bevel gears are now being used extensively by some automobile manufacturers instead of the standard-tooth bevel gears. By using a 20-degree pressure angle and shortening the height of the gear tooth, a stronger gear is obtained, which requires no under-cutting but which has better rolling contact. This type of tooth is therefore recommended for machinery requiring gearing that will withstand severe stresses. The method of calculating the parts of this gear is best shown by an example.

Let it be required to make a pair of stub-tooth bevel gears of 4/5 diametral pitch, with 46 teeth in the gear, 15 teeth in the pinion, and a 20-degree pressure angle. As the tangent of the pitch angle of the pinion is 15 ÷ 46 = 0.32609, the angle is 18 degrees, 4 minutes. The pitch angle of the gear is then 90 degrees — 18 degrees, 4 minutes = 71 degrees, 56 minutes.



Stub-tooth Bevel Gears of Forty-six and Fifteen Teeth

The pitch diameter of the pinion is 15 ÷ 4 = 3.75 inches, and of the gear, 46 ÷ 4 = 11.5 inches. The addendum of both the gear and the pinion is 0.2 inch. The cone distance is one-half the pitch diameter of the gear divided by the sine of the pitch angle of the gear, or 11.5 ÷ 2 ÷ 0.9507 = 6.048 inches. Then, dividing the addendum, 0.2 inch, by the cone distance, 6.048 inches, gives the tangent of the increment angle for both the gear and the pinion; or, 0.2 ÷ 6.048 = 0.033068. This angle is therefore 1 degree, 54 minutes. The face angle of the gear is 71 degrees, 56 minutes + 1 degree, 54 minutes = 73 degrees, 50 minutes; and the face angle of the pinion is 18 degrees, 4 minutes + 1 degree, 54 minutes = 19 degrees, 58 minutes.

The dedendum for both the gear and the pinion is 0.25 inch. The tangent of the dedendum angle or the angle of decrement for both gears is therefore 0.25 ÷ 6.048 = 0.04133; which is the tangent of 2 degrees, 22 minutes. The cutting angle of the gear is then 71 degrees, 56 minutes — 2 degrees, 22 minutes = 69 degrees, 34 minutes; and of the pinion, 18 degrees, 4 minutes — 2 degrees, 22 minutes = 15 degrees, 42 minutes. The diameter increment of the gear is the product of twice the addendum and the cosine of the pitch angle, or 2 × 0.2 × 0.31012 = 0.124 inch. Adding this to the pitch diameter of the gear gives the outside diameter of the gear, or 11.5 inches + 0.124 inch = 11.624 inches. The diameter increment of the pinion is the product of twice the addendum and the cosine of the pitch angle, or 2 × 0.2 × 0.9507 = 0.38. Adding this to the pitch diameter of the pinion gives the outside diameter, or 3.75 inches + 0.38 inch = 4.13 inches. As the addendum is 0.2 inch and the dedendum is 0.25 inch, the total depth of the gear tooth is 0.45 inch. The thickness of the tooth is 0.3926 inch.

Brooklyn, N. Y. EDWARD J. RANTSCH

DIE FOR PRODUCING SMALL STEEL PIECES IN ONE OPERATION

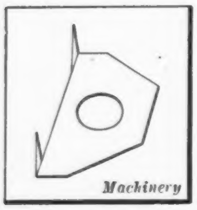


Fig. 1. Piece formed by Die shown in Fig. 2

Fig. 1 shows a small piece made from 1/32-inch steel, and Fig. 2 shows the die for producing it in one operation. Similar dies can be used for work of this kind, where great accuracy is not required, where the metal is light, and where the bending point is reduced, so that it is not necessary for the forming punch to bottom the piece against the die to form the bend. As the part is pushed through the die out of the way, the operation is much faster than it would be if the part were left on the die to be slid or knocked off.

Fig. 2 shows the plan of the die without the stripper and the front view of the punch and die. The hole is pierced at *A* and the piece formed, cut off, and dropped through at *B*. *D* and *E* are the cutting edges and *F* the forming edge, which is 3/16 inch higher than the cutting edges. The end of stop *C* is the same size and shape as the cutting-off punch, so that the end of the strip, after being cut, centers against it. The stripper *G* is 1/4 inch thick and extends 3/8 inch above the die, leaving 3/16 inch under it, over the forming edge. The cutting-off and forming punch *H* is made the full size of the hole, except at the two corners where clearance is allowed for the two prongs. This leaves a space between the prongs for it to slide against the forming edge, to back up the cut. The guide pins are of one-inch drill rod; they are not hardened and are left with the original finish. They are a drive fit in the shoe and a nice sliding fit in the punch-holder, and have no bushings. This construction will outlast two or three dies and has been used for the last five years.

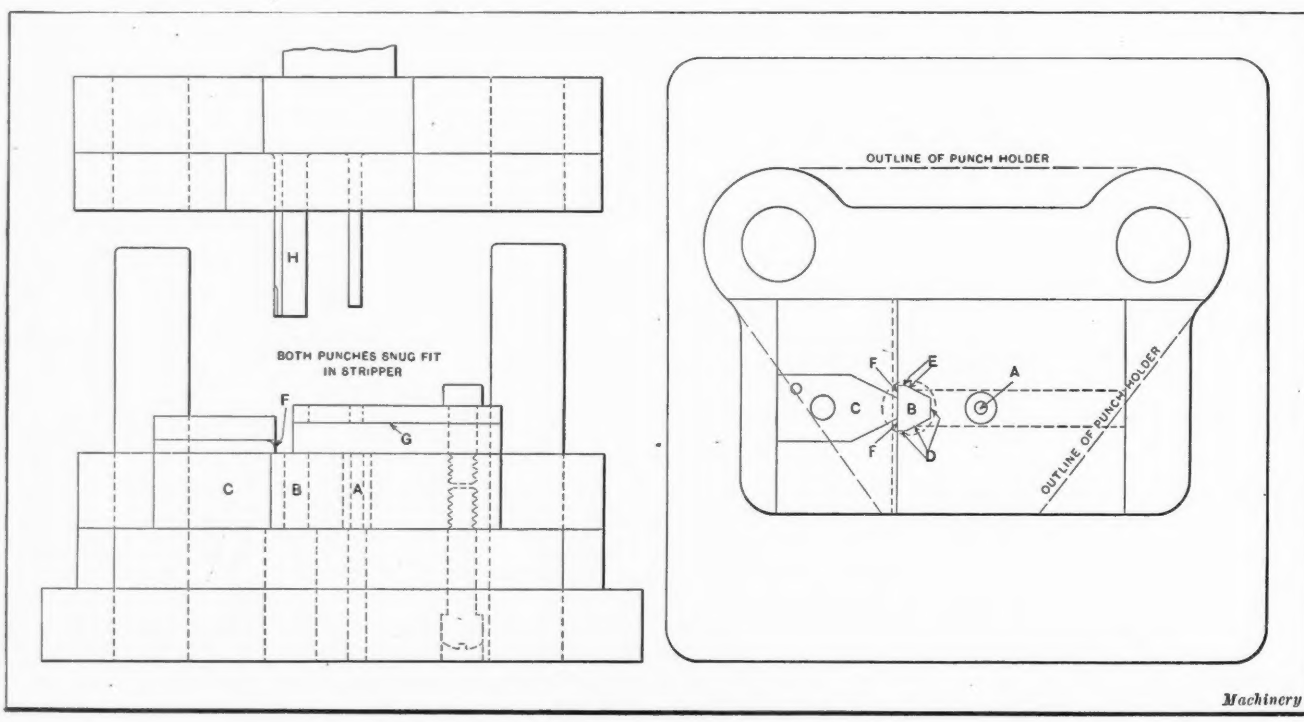


Fig. 2. Die for forming Small Steel Piece shown in Fig. 1

In operation, the strip is fed directly against the stop *C*; this gives a blank without prongs or hole. The second blank also lacks the hole, but after this blank a complete piece is produced at each stroke. If this material is bought in coils, the loss of two pieces at the beginning of each coil does not amount to anything. The press may be run continuously to the end of the coil, for the stop is positive and cannot be run over and the part drops through without scrap. As the punches rise after the cut, they carry the strip against the stripper, so that it is pushed forward on that level, with the prongs at the end resting on the forming edge. On the downward stroke, the punch bends the prongs while the blank is still part of the strip, which gives the prongs the necessary support, for the bend is completed before the piece is cut off. The forming edge is under-cut so that the piece is free to drop away from the punch and will not follow it back.

Plymouth, Mich. W. B. Greenleaf

A SIMPLE JIG

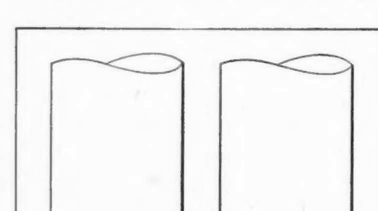
The toolmaker in the jobbing shop meets many difficulties; sometimes he is called upon to be a designer, without making elaborate details. The other day it was necessary to make three brass plates containing 280 steel pins, 3/32 inch in diameter, 1/2 inch apart. For one plate the holes for the pins were laid out by the aid of a milling machine, as accuracy was essential. But this method was too slow and not accurate enough. So four rows of holes were laid out on a piece of steel 3/16 by 6 by 3 inches, which was used as a jig.

As the brass plates were milled up square, it was easy to clamp the jig for the first four rows of holes. Then, after these holes were drilled, the jig was unclamped and moved along on the plate, being located by pins that passed through the jig into two of the holes drilled in the brass plate. This method was continued until all the holes were drilled. The plate laid out by the milling machine was not nearly so true as those laid out by means of the jig; this may be due to the fact that when milling machines are used much the screws wear and the graduated collars are not absolutely accurate.

New Haven, Conn. Eric Lee

HEAVY-DUTY PUNCH

If a heavy-duty punch is ground off as illustrated, it will take less power to operate, start more easily, and shear a smoother hole than it will if ground as shown in the April number of Machinery. I have used punches ground as illustrated up to two inches in diameter on material two inches thick, and have found that if the bevel is not greater than 3/32 inch in two inches, the punches stand up to the work and give better service.



Heavy-duty Punch

C. G. Williams

Miles City, Mont.

TO PREVENT BREAKING VULCANITE-MOUNTED MAGNIFYING GLASSES

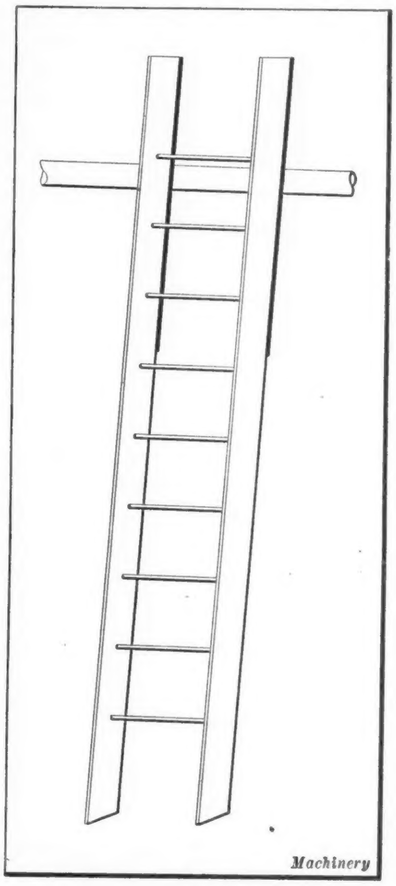
A simple and effective method of preventing the breaking of the ferrule of vulcanite-mounted magnifying glasses consists of placing several rubber bands, about 1/4-inch wide, around the ferrule at the glass end, allowing the rubber to project slightly beyond the ferrule. When dropped, the glass end, which is the heavier, will almost always strike the floor first, and if not protected, the vulcanite, being very thin at this end, will chip off and allow the glass to fall out. These bands act as a cushion and protect the vulcanite.

Providence, R. I. R. C. SCHOLZ

SAFETY ATTACHMENT FOR LADDERS

Several accidents occurred in the plant in which the writer is employed to the men who inspected, repaired, and oiled the lineshafting, before it was noticed that these were due chiefly to the fact that the ladders slipped when the men leaned too far to one side to reach a bearing, etc. Therefore, to prevent the ladder slipping along the shaft on which it was resting, rubber strips were tacked along both sides of the ladder, as indicated by the heavy lines in the accompanying illustration. This device worked out very satisfactorily, and no further accidents have been due to this source. Although not shown, the base of the ladder was also equipped with iron claws to prevent slippage at that point.

Philadelphia, Pa. W. A. LAILER



Ladder with Rubber Strips to prevent Slipping

HARDENING KINK

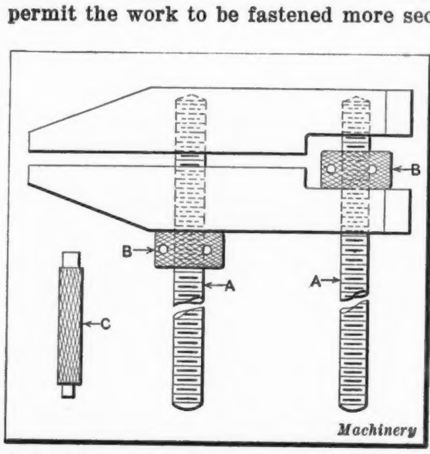
Toolmakers and diemakers often experience difficulty from dies expanding during hardening. If, when a die is put in the furnace, it is placed top face down on a firebrick slab, it will get more heat than if placed bottom face down, which is the usual method. The hole will then contract, instead of expanding, and will allow about 0.002 inch for stoning. When too much metal has been filed from the hole in the die, there is more chance of the templet fitting if the die is hardened this way.

Long Island City, N. Y. E. KERN

TOOLMAKER'S CLAMP

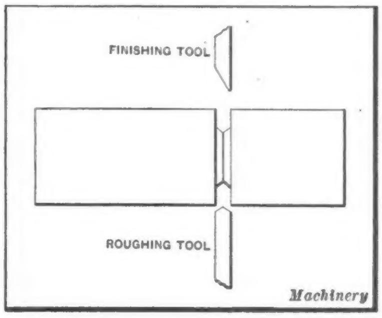
The clamp shown in the accompanying illustration is one of the most useful to be found. As the screws *A* are headless and pass through only one side, it is possible to get to the bottom working surface. The nuts *B* permit the work to be fastened more securely than the screws in the ordinary form of clamp; the nuts are tightened by means of the pin *C*. This clamp is made of cold-rolled steel and is casehardened; the nuts are made of carbon steel and are drawn to a dark brown, and the screws are made of steel (Stubs gage) and tempered in oil.

AUGUST J. LEJEUNE
Ambridge, Pa.



Handy Parallel Clamp for Toolmakers and Diemakers

CUTTING-OFF TOOLS



Roughing and Finishing Cutting-off Tools

The accompanying illustration shows two cutting-off tools mounted on one cross-slide. With a roughing tool shaped as shown, greater speed and better work is insured, and a minimum of power is required. This tool is self-clearing on the sides and guides straight, an important feature when cutting off thin disks of large diameter. When the roughing tool has been fed to a certain point, it is backed off and the finishing tool on the opposite side is brought up to finish the cut. The small amount of work done by the finishing tool makes it possible for this tool to be ground at an extreme angle, thereby making a clean cut.

Oak Park, Ill. P. BERTLES

GRINDING EDGE TOOLS ON EMERY WHEEL

The article entitled "Wheel Dressing" in the June number of MACHINERY recalls an incident that shows what the average woodworker thinks of the emery wheel for grinding edge tools. The writer was assisting the boss patternmaker to make a large pattern, which was being turned in the lathe, when it became necessary to grind the wood-turning chisel. This was made from a flat file 5/16 by 1 1/2 inch, and considerable stock had to be removed to put the chisel in good working condition. As the shop grindstone was worn down pretty close to the hub, the writer began to grind the chisel on the emery wheel, but was soon stopped by the boss, who called him down for committing such an unmechanical act.

In that particular shop the grinding of an edge tool on an emery wheel might be considered unmechanical, but the writer did it long before he worked there and has done it ever since, and his edge tools are in good condition and in use every day. A great many first-class mechanics in the wood-working lines have an idea that the emery wheel has a bad effect on edge tools. Perhaps experiences have shown this to be true, but if you inquire from these men, "Do you keep the wheel in good cutting condition?" their answer is in a great many instances, "I never bother about that; an emery wheel requires no attention."

Wood-turning tools become dull very quickly; they are made from heavy stock, and grinding, even on a good grindstone, is slow and tedious. In a great many shops, the grindstone is located in a dark corner some distance from the wood-turning lathes, and during the process of turning a great many patterns, several trips to the stone must be made. The writer grinds his turning tools on an emery wheel, which he has mounted on a wooden faceplate that fits on either end of the lathe spindle. When turning between centers or on a faceplate at the front end of the lathe, the emery wheel is mounted at the back end of the spindle, and when turning at the back end of the spindle, the emery wheel is placed at the front. For the small lathe, a small wheel is mounted on a wooden center made like the regular lathe center and fitted to the hole in the spindle. By this plan, the turning tools are easily and quickly ground without leaving the lathe. All inside-ground gouges are ground on the small wheel, as it is but a moment's

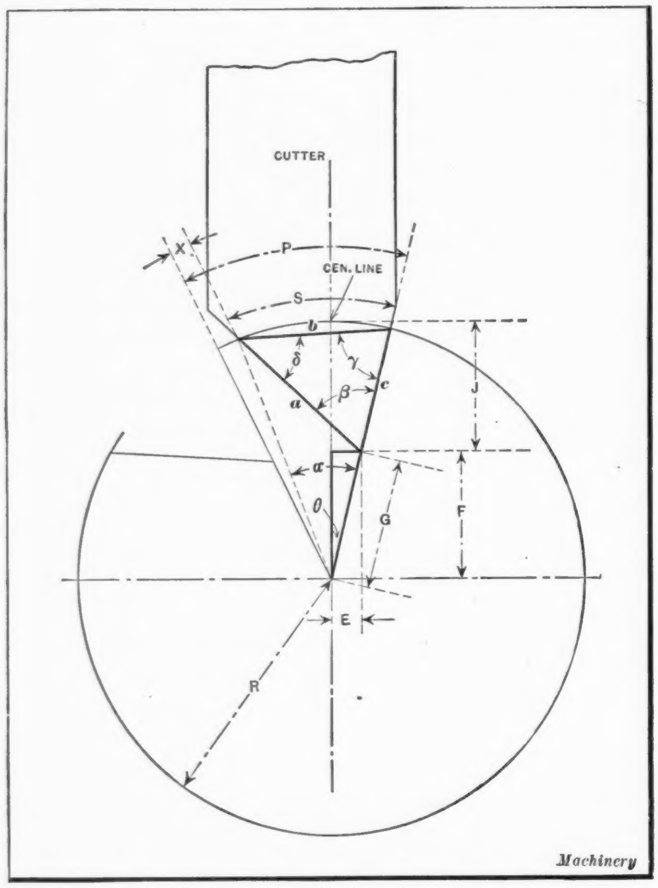


Diagram for finding Set-over, Depth, etc., of Cutter

work, with the aid of the dresser, to form the wheel to the curve of the gouge. The wheels and the dresser are part of the writer's turning-tool kit; they are his own property and he keeps them in good cutting condition. A clean wheel will do good and fast work; a dirty, glazed, neglected wheel will not grind burrs off rough castings, to say nothing of edge tools.

Kenosha, Wis. M. E. DUGGAN

SETTING AN ANGULAR CUTTER FOR MILLING SPIRALS

The writer recently had a number of spiral end-mills to flute, and not being able to find a suitable formula for obtaining the necessary set-over, full depth, etc., used the solution given herewith. The outside diameter, number of teeth, and width of land are the dimensions furnished. In this solution it is assumed that the vertex of the cutter angles is a point, N = number of teeth; X = land; R = radius. The cutter angles were 53 and 12 degrees. Arc $P = \frac{2R\pi}{N}$; arc $S = P - X$; $\alpha = \frac{360 \text{ degrees}}{\frac{2R\pi}{S}}$; $\gamma = \frac{180 \text{ degrees} - \alpha}{2}$; $\beta = 65$ degrees; $\delta = 180$ degrees $- (\gamma + \beta)$; $b = 2R \times \sin \frac{\alpha}{2}$; $c = \frac{b \times \sin \delta}{\sin \beta}$; $G = R - c$; $\theta = 12$ degrees; $E = G \times \sin \theta$ = set-over; $F = G \times \cos \theta$; $J = R - F$ = full depth.

Denver, Colo. STANLEY EDWARDS

LIGHTING STAIRCASES

Recently, the writer called attention, in a certain factory, to the necessity of having electric lights at the foot of each staircase. Light at the top of the flight casts a shadow on each step and makes the stairs dangerous. He also found a swinging door opening outward at the foot of one of the stairs, tending to block the corner on the turning. Such a door should not be used as a fire exit, unless it can be locked back when open, and it is a poor arrangement in any case.

New York City ROBERT GRIMSHAW

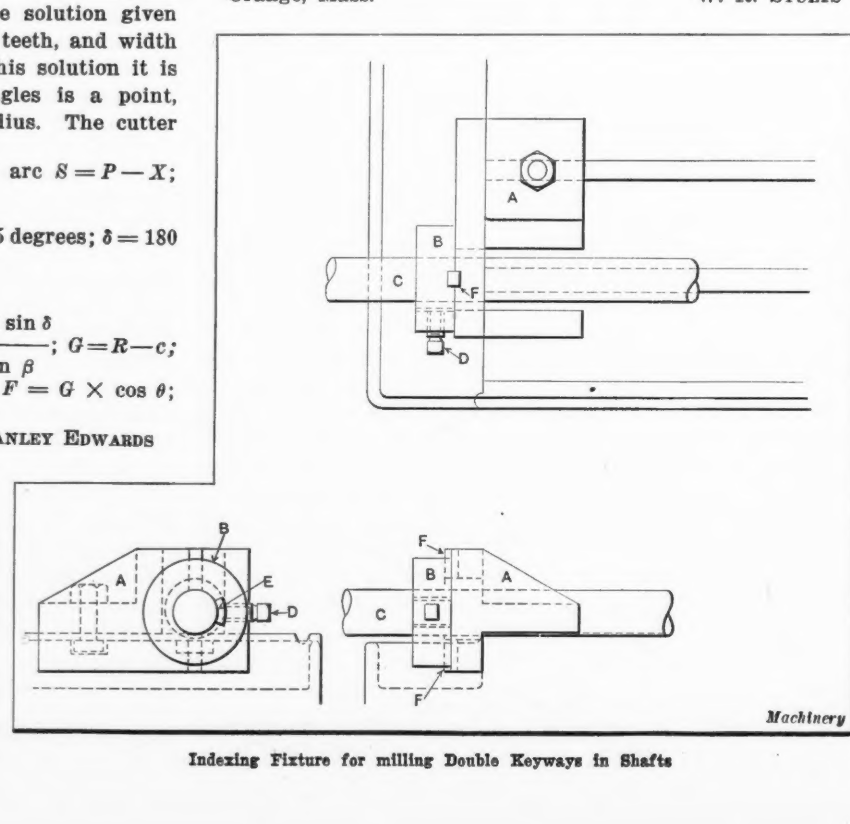
DOUBLE KEYWAY MILLING FIXTURE

The accompanying illustration shows an indexing fixture that was designed for milling opposite keyways for movable saws in long saw arbors on wood-working machinery. The keyways are cut in opposite sides in order to balance the shafts, as they run at high speed. The fixture consists of a cast-iron bracket *A* and a steel collar *B* which is fastened to the shaft *C* to be milled, by a set-screw *D* that bears on a shoe *E*. The bracket *A* extends down over the end of the platen of the milling machine and is held in place by a bolt in the T-slot next to that in which the work is laid. The collar *B* thus forms a stop, bearing against the bracket and the end of the platen to resist the action of the milling cutter. The collar is slotted to receive two keys *F*, which are fastened in slots in the body *A* of the fixture; the slots in the collar are made central with the hole. No key is used to locate the fixture in relation to the T-slots, as this would entail locating the key an exact distance from the indexing keys, and this would be affected by any variation in the chamfer on the edges of the T-slot where the work is located.

In operation, the work and fixture are put on the milling-machine table, and the holding-down bolt is tightened slightly by hand; the hole for this bolt is 1/16 inch larger than the bolt. Collar *B* is then set up solidly on the shaft in the proper position lengthwise, and the shaft is strapped down over the T-slot with U-straps in the customary manner. The holding-down bolt for the fixture is now tightened, as the work has located it in the correct position. When the slot has been milled, the U-straps are loosened, the shaft is drawn back until collar *B* clears keys *F* (without loosening the collar), the shaft is given a half turn, and the collar is slipped over the keys again. The straps are then tightened and the second slot is milled.

This fixture has done very satisfactory work, indexing the slots perfectly without the necessity of putting the shafts on index centers, which in most cases would be impossible owing to the length of the shafts handled. The accuracy of the fixture is dependent wholly on the accuracy with which the slot in collar *B* is centered; this can easily be done very accurately. The fixture is so proportioned as to handle shafts from 1 7/16 to 2 3/16 inches in diameter, a collar being used for each size of shaft that is milled.

Orange, Mass. W. R. STULTS



Indexing Fixture for milling Double Keyways in Shafts

HOW AND WHY

QUESTIONS ON PRACTICAL SUBJECTS OF GENERAL INTEREST

HOBS AND MULTI-CUTTERS

A. L. K.—We have had a difference of opinion over the meaning of the term "hob." What is the correct definition?

A.—The term hob, when applied to a tool for cutting threads or gear teeth, means a cutter having teeth in a helical path like a tap. The term hob is sometimes erroneously applied to multi-cutters used in thread milling machines for cutting threads. These cutters do not have the teeth in a helix, but in parallel circumferential rows.

MARKING COUNTERSINK ANGLES ON DRAWINGS

H. G. F.—We have had a lengthy discussion on the proper method of marking the angle of countersinks on a drawing. I made a drawing which indicated three holes for screws with countersink heads, and marked them "25/64 drill, 76 degrees countersink." When the pieces were made and delivered, it was found that the included angle of the countersink was 104 degrees, that is, 180 degrees minus 76 degrees. Will you kindly tell us what is regarded as the proper method of marking countersink angles?

A.—The angle of countersink is always the included angle and there is no practice warranting anyone using the supplement angle instead. The angles of twist drills, countersinks, and similar tools, are always expressed as the included angle or half the included angle.

WHY DIDN'T IT EXPLODE?

W. S. R.—A small can of evaporated milk—not the thickened condensed milk, but the 50 per cent reduction kind—was left in a pot of water boiling furiously for twenty minutes after it came to a boil from 96 degrees F. The can was absolutely tight and there was no apparent escape of steam. Early in the boiling the can ends bulged, indicating internal pressure, but that was all. Why didn't it explode?

A.—The probability is that the ends bulged sufficiently to crack the soldering at some point and make a minute opening through which sufficient steam escaped to prevent explosion. However, there is another side to the matter, and that is the slowness of heat transfer under certain conditions. It may be that even after having been in boiling water for twenty minutes, the whole mass of milk had not yet reached boiling temperature. The question is submitted to the readers.

GRINDING TAPER PLUGS IN BRASS VALVES

F. E. R.—What is an approved method of grinding in the taper plugs of brass plug cocks? I have had trouble in making a tight job, using fine ground glass and flour emery as abrasives.

A.—The grinding in of brass taper plugs in valve bodies is a job requiring considerable care and skill to insure water-tightness. Emery should never be used, as it tends to cut circumferential grooves, and the abrasive action continues after the valve is put in use, due to minute particles of emery that are left embedded in the soft brass. Valve manufacturers use fine burnt foundry sand mixed with machine oil to form a paste abrasive for grinding plug valves. Hard soap is rubbed on the plug at short intervals to furnish the necessary lubrication. The action when grinding in a plug valve should be an oscillating motion, and the plug should be pulled out of the valve body frequently to distribute the abrasive evenly and to prevent cutting. The fine burnt sand and hard soap give good results; when the grinding is finished, the surface may be easily cleaned and no cutting will take place afterward.

CASTING LAMP BASES AND COFFIN HANDLES WITHOUT CORES

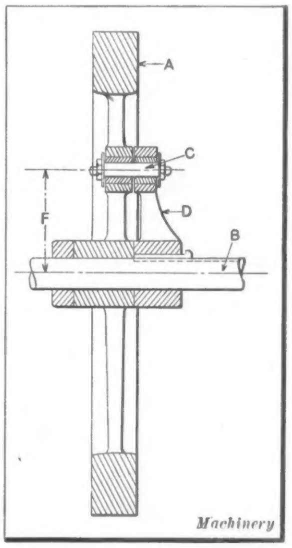
H. T. S.—Will you tell me how fancy lamp bases, coffin handles and other articles requiring a high finish are cast hollow without using cores?

A.—Fancy lamp bases are cast in iron molds by pouring in a comparatively small amount of alloy having a low melting point and turning the mold about while a thin shell of the metal hardens. When the desired thickness has hardened, the workman tilts the mold so that the molten metal runs out, leaving a thin shell of metal in the mold, which is then removed. Essentially the same process is employed in casting coffin handles. The mold is provided with a gooseneck into which the britannia metal is poured. The mold is allowed to stand for a few seconds until the metal hardens and then turned over and the molten metal poured out, leaving the center hollow. The workman can make a thick or thin shell by simply varying the time that the metal is allowed to stand in the mold. Considerable skill is required to make a shell of uniform thickness, especially thin shells. The chief art in this trade is in securing uniform thickness of the shell and using the minimum of metal.

RESISTANCE OF SHEAR PIN

P. G. P.—We have fitted a flywheel with the safety device shown in the illustration. A one-inch square steel pin *C* is held between steel bushings, one bushing being held in the flywheel arm and the other in a spider *D* keyed to the shaft *B*. The flywheel *A* is free to revolve around the shaft, in case an overload should shear pin *C*. We have assumed that it would require 60,000 pounds to shear a steel pin one inch square and also that the pin would be severed when sheared about one-third its thickness. The question is, does the distance *F* affect the resistance of the shear pin? It seems to me that it must remain the same wherever placed.

A.—The position of the shear pin positively affects its effective shearing resistance. If it is located at the hub, its resistance to the action of the flywheel will be much less effective than if it is located in the rim. If the shear pin is located 20 inches from the shaft center, its effective resistance to check the flywheel will be twice that if placed only 10 inches from the center. The principle is exactly the same as found in a pair of shears. If a thick wire is to be sheared, you place it as near the pivot or hinge of the shears as possible in order to get the most effective leverage. The farther the wire is placed from the pivot, the harder it is to force the jaws through it. The wire cuts no harder, however, in one position than in the other, but the effective leverage is lessened as the wire is moved away from the pivot.



Flywheel loosely mounted on Shaft and driven by Shear-pin

MELTING COPPER IN AN IRON CUPOLA

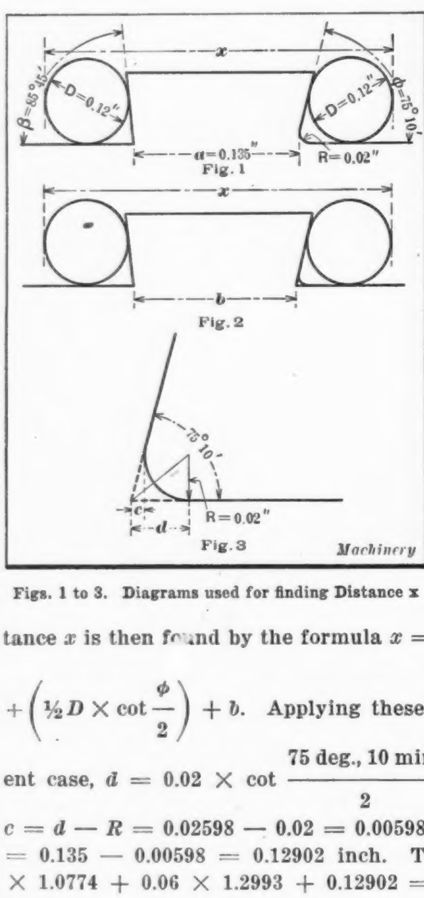
E. P. F. & N. Co.—We have a small brass furnace and an iron cupola in our foundry and have to make three bronze castings weighing one ton each. We understand that the copper can be melted in the iron cupola and the tin, zinc and lead required for making brass or bronze mixtures may be melted in the brass furnace and heated in the cupola as the copper runs from the iron cupola. Will you please advise?

A.—Large quantities of copper for making bronze castings may be melted in an iron cupola by using a reduced tuyere area and a blast pressure of 8 to 10 ounces. The tin and other metals used for making the bronze should be melted in an ordinary crucible brass furnace and poured into a large ladle into which the copper is tapped from the cupola. Care

should be exercised in melting the copper to use a fuel having a low sulphur content. After tapping the cupola, the melted copper should be covered with lump charcoal to prevent oxidation. Heavy brass castings may also be made by melting in an iron cupola. The practice of Dibert, Bancroft & Ross Co., Ltd., of New Orleans, Pa., in melting brass in the cupola, is to charge with 90 per cent heavy red brass and 10 per cent pure copper. A very light blast is used while melting. The losses from oxidation in the foregoing mixture vary according to the quality of brass with which the cupola is charged, but are rarely more than 5 per cent, affecting mostly the zinc and tin. To secure the proportions desired in the casting, zinc and tin, previously melted in a brass furnace, are added to the ladle after tapping from the cupola. The company has not thought it necessary to use deoxidizers in the ladle, although they are regarded as beneficial in some cases.

MEASURING DOVETAIL SLIDES

S. C. B.—Please show me how to calculate the distance over the two wires used in measuring the dovetailed angles shown in Fig. 1, the dimensions of which are as given.



Figs. 1 to 3. Diagrams used for finding Distance x

A.—To calculate the distance x, it is first necessary to know the distance b, Fig. 2, between the sharp corners of the angles; therefore, the distance c, Fig. 3, must be found. This distance may be obtained by first finding the distance d from the formula $d = R \cot \frac{\phi}{2}$; then $c = d - R$. This value of c must be subtracted from the length a to give the distance b. The distance x is then found by the formula $x = D + \left(\frac{1}{2}D \times \cot \frac{\beta}{2}\right) + \left(\frac{1}{2}D \times \cot \frac{\phi}{2}\right) + b$. Applying these formulas to the present case, $d = 0.02 \times \cot \frac{75 \text{ deg., } 10 \text{ min.}}{2} = 0.02598$ inch; so $c = d - R = 0.02598 - 0.02 = 0.00598$ inch, and $b = a - c = 0.135 - 0.00598 = 0.12902$ inch. Then $x = 0.12 + 0.06 \times 1.0774 + 0.06 \times 1.2993 + 0.12902 = 0.3916$ inch.

MEASURING FORCE OF A HAMMER BLOW

C. C. B.—To test the force of a blow in hammers, we take a round lead plug, one inch in diameter and one inch high, and strike it one blow with the hammer; then we take a duplicate plug, put it in a Riehle testing machine, and press this plug to the thickness of the plug that has been struck. Is the pressure indicated by the machine equal to the force of the blow? Some people say it is, while others take the opposite view; which are right?

A.—The fundamental formula for ascertaining the force of a blow is $ft = mv$, in which f = force of blow, t = time required to bring body to rest, m = mass of body, and v = velocity of body at instant of striking. It is seldom possible to measure t and it is usually difficult to ascertain v; consequently it is customary to determine the force of a blow, with more or less accuracy, by employing the principle of work. In the case of a pile driver, this method gives fairly satisfactory results, the formula being, theoretically, $wh = fs$, in which w = weight of falling body, h = height of fall, f = force of blow = resistance offered by pile, and s = distance pile is driven by blow; the weight w and the force f are in pounds and h and s are in feet. In the present case, the hammer is assisted by an additional force, and if this is known or can be found, it must be added to w. Even then, the result will not be exact, because every body, even lead, has a certain amount of elasticity and will not entirely retain the shape it had at the instant of greatest compression. Solving the foregoing formula for f, $f = \frac{wh}{s}$. If it is assumed that the work done in the testing machine is equal to wh, all that is necessary is to multiply and divide the pressure p recorded by the machine by s (measured in feet), and the result ($f = p$) will be a fair approximation to the force of the blow struck by the hammer. But this assumption implies that the pressure is uniform from the instant that the plug begins to be compressed until the required thickness is reached, which is by no means the case. It is also probable that a greater force will be required in the machine than the almost instantaneous force exerted by the hammer; however, it is reasonable to assume that your method is not far wrong. J. J.

CONCERNING THE DIAMETER OF A SHAFT

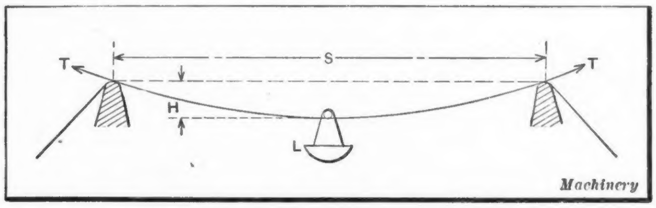
B. C. L.—In an article showing how to calculate the diameter of a steel shaft, I find the statement: "If the diameter is less than 13.6 inches, use Formula (1); but if it is greater than 13.6 inches, use Formula (2)." The formulas are as follows, in which d is the diameter, in inches, H is the horsepower transmitted, and N is number of revolutions per minute: $d = 4.7\sqrt[4]{\frac{H}{N}}$ (1), and $d = 3.3\sqrt[3]{\frac{H}{N}}$ (2). Why are the formulas so different, and how is the number 13.6 obtained?

A.—When a shaft transmits power, it is subjected to a twisting stress, and the resulting deflection is measured by the so-called "angle of twist." It is not desirable to have this angle exceed a certain limit, and when it is taken into account, Formula (1) is derived. But when the angle of twist is neglected and only the strength of the shaft is considered, Formula (2) is obtained. It is evident that there must be one diameter for which both formulas will give the same result; to find it, proceed as follows: Placing the right-hand members of the two equations equal to each other, $4.7\left(\frac{H}{N}\right)^{\frac{1}{4}} = 3.3\left(\frac{H}{N}\right)^{\frac{1}{3}}$, or $4.7\left(\frac{H}{N}\right)^{\frac{3}{12}} = 3.3\left(\frac{H}{N}\right)^{\frac{4}{12}}$. From the last expression, obtain by division $\left(\frac{H}{N}\right)^{\frac{1}{12}} = \frac{4.7}{3.3}$. Raising both members to the 12th power, $\frac{H}{N} = \left(\frac{4.7}{3.3}\right)^{12} = 69.675$, using a five-place table of logarithms. Substituting this value of $\frac{H}{N}$ in either of the two formulas, the value of d is found to be 13.579, say 13.6. In practice, that formula should be used which gives the larger value for d. If the diameter is less than 13.6, Formula (1) will give the larger value; but if the diameter is greater than 13.6, Formula (2) will give the larger value. In the case of engine crankshafts, neither formula will give very good results, because the heavy loads induce bending stresses, which must also be considered, the resulting formula being somewhat complicated. J. J.

STRENGTH OF ROPE FOR A CABLE BRIDGE

W. H. D.—We wish to put a cable bridge across a small stream and would like to know what size steel-wire rope, nineteen wires to the strand, will be necessary. The span is 85 feet, and the sag H must not exceed 5 feet; the greatest weight of the car and contents is 2500 pounds.

A.—As may be supposed, it is not possible to derive a formula that will give exact results; that is, results that will be closer than, at the most, two significant figures. The ten-



Determination of Strength of Rope for a Cable Bridge

sion T in the rope may be found quite accurately by means of the following formula:

$$T = L\left(\frac{S}{4H} + \frac{4HL}{S^2W + 2SL}\right) + \frac{S^2W}{8H} + HW$$

in which S = span, in feet;
H = sag, in feet;
L = maximum weight of car and contents, in pounds;
W = weight of rope, in pounds, per foot of length.

In order to find a value for T, it is necessary first to determine the value of W. When the values of S and L are comparatively large, as in this case, and steel rope is used, W exerts but a small effect on T; hence, making $W = 0$, a value for T is found, by means of which the size of the rope can be determined, approximately. In the present case,

$$T = 2500 \times \left(\frac{85}{4 \times 5} + \frac{4 \times 5 \times 2500}{2 \times 85 \times 2500}\right) = 10{,}900 \text{ pounds, ap-}$$

proximately. It is necessary to allow a reasonable factor of safety, the value of which will depend upon how frequently the cable is used and how often the maximum load is carried; it may be as low as 3 or as high as 6. Assuming that it is 4.5, the rope should have a breaking strength of $10{,}900 \times 4.5 = 49{,}050$ pounds, say 25 tons. A cast-steel wire rope 7/8 inch in diameter has a breaking strength of 25 tons and weighs 1.2 pound per foot. Substituting this value for W in the complete formula for T,

$$T = 2500 \times \left(\frac{85}{4 \times 5} + \frac{4 \times 5 \times 2500}{85^2 \times 1.2 + 2 \times 85 \times 2500}\right) + \frac{85^2 \times 1.2}{8 \times 5}$$

$+ 5 \times 1.2 = 11{,}135$ pounds. Multiplying by the factor of safety, $11{,}135 \times 4.5 = 50{,}107$ pounds, or 25 tons, very nearly. Hence a 7/8-inch rope will be large enough; but if the cable bridge is to be subjected to heavy usage, it might be well to use a 1-inch rope. J. J.

TRIGONOMETRIC FUNCTIONS FOR ANY ANGLE

J. P. C.—I should appreciate a rule that is easily remembered for finding the trigonometric functions for angles greater than 90 degrees, using an ordinary table.

A.—Let x be any angle less than 90 degrees; then any other angle can be expressed as $n \times 90$ degrees $+ x$, n being an integer. For example, 286 degrees, 42 minutes may be written 3×90 degrees + 16 degrees, 42 minutes; 563 degrees, 19 minutes = 6×90 degrees + 23 degrees, 19 minutes; and 52 degrees, 24 minutes = 0×90 degrees + 52 degrees, 24 minutes. As shown in Fig. 1, angles are assumed to increase by the radius starting from OA and moving counter-clockwise about the circle; hence $AOM = x$, $AON = 90$ degrees $+ x$, $AOP = 2 \times 90$ degrees $+ x$, and $AOQ = 3 \times 90$ degrees $+ x$. If the angle is greater than 360 degrees (= 4×90 degrees), subtract 4 (or some multiple of 4), so that n will be less than 4, but not negative. For example, the functions of 563 degrees = 6×90 degrees + 23 degrees are exactly the same as for 2×90 degrees + 23 degrees = 203 degrees. Having expressed the angle in the form $n \times 90$ degrees $+ x$, note whether n is even or odd; if it is even (0, 2, 4, etc.), the numerical values of the functions will be the same as those for x; but if n is odd (1, 3, 5, etc.), the numerical value of the functions will be the same as those for the cofunctions of x. Thus the numerical value of the sine of 203 degrees = 2×90 degrees + 23 degrees is sin 23 degrees; of 296 degrees = 3×90 degrees + 26 degrees is cos 26 degrees, cot 163 degrees = 1×90 degrees + 73 degrees = tan 73 degrees, etc. The sign of the function is determined by noting the quadrant in which the revolving radius stops. As shown in Fig. 2, all the functions are positive for the first quadrant AB. Note that for the upper semicircle ABC, the sine is positive and for the lower semicircle it is negative. For the right-hand semicircle BAD, the cosine is positive; and for the left-hand semicircle, it is negative. In the diagonally opposite quadrants AB and CD, the tangent and cotangent are positive, and in the other two diagonally opposite quadrants BC and DA, they are negative. From this it follows that cos 685 degrees, 13 minutes, 33 seconds = cos 7×90 degrees + 55 degrees, 13 minutes, 33 seconds = cos 3×90 degrees + 55 degrees, 13 minutes, 33 seconds = + sin 55 degrees, 13 minutes, 33 seconds. The name of the function changes from the cosine to the sine because n is odd; the sign is plus because the revolving radius stops between D and A in the fourth quadrant, and the cosine of any angle in this quadrant is +. The sign of the secant is the same as that of the cosine of the same angle, since the secant is the reciprocal of the cosine; for the same reason, the sign of the cosecant is the same as that of the sine of the same angle. J. J.

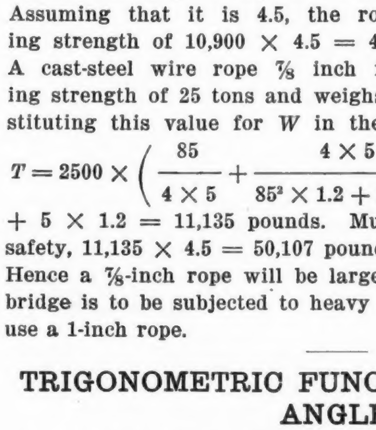


Fig. 1. Angle Diagram

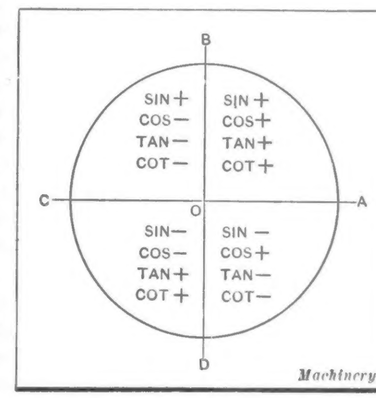


Fig. 2. Signs of Functions in Each Quadrant

GANG AND MULTIPLE-SPINDLE DRILLING MACHINES

E. K. H.—What is the distinction between an upright multiple-spindle drilling machine and a gang drilling machine? It is my impression that a machine is classified as a multiple-spindle drilling machine if there are two or more spindles carried by a single frame, and that it is known as a gang drilling machine if there are two or more spindles carried by individual machine frames.

A.—This question was submitted to the principal makers of multiple-spindle and gang drilling machines, but there seems to be no general agreement. F. K. Hendrickson, of the Reed-Prentice Co., Worcester, Mass., writes: "Originally a gang drill meant not only a machine composed of a series of independent frames or columns carrying one or more spindles, but any type of machine wherein there were several spindles. I note that it is your impression that a multiple-spindle drill is composed of two or more spindles carried by a single machine frame and that a gang drill is composed of two or more spindles carried by individual frames. If your meaning of the word 'frame' applies to the entire column or unit, the distinction would be quite definite, but if your understanding of the word frame merely suggests the member carrying the spindle, the situation becomes a little more complicated. In referring to the old type of gang drills such as were originally used by the railroads, a main housing with cross-rail was a general construction upon which were mounted several heads, each carrying its own spindle or multiple spindles. This type of machine was generally known as a gang drill. It is my opinion that a multiple-spindle drilling machine is any drilling machine having a single housing, with all the spindles either mounted in a single head or in independent heads and supported by the single housing, while a gang drill is a series of practically independent machines driven from one source of power and mounted either on a single base or independently in a group."

G. E. Randles, vice-president of the Foote-Burt Co., Cleveland, Ohio, states that it is their opinion that any drilling machine having more than one spindle is a multiple drill, and from this the different types should be classified, such as: universally adjustable (which would be the Baush type); fixed center independent feed, the type of drilling machine in which the spindle heads are mounted on a common cross-rail and adjustable in a straight line for centers, but provided with an independent feed for each spindle. "The gang type is this same sort of machine, except where the feed is connected up in a gang and the feed on all spindles is engaged and disengaged at one time and from one point. We think this type of machine is more truly the gang drill than the type to which you refer where several individual machines may be set on one base with one common table, such as the Barnes type. We would say that the correct term for a battery of machines of this sort would be fixed by the size of the machine set in a gang, no matter what number may be used. We build practically all types of multiple-spindle drills and class everything of more than one spindle as a multiple drill, but also classify them beyond this as universally adjustable multiple drills, independent-feed multiple drills, gang-type multiple drills, etc."

G. E. Hallenbeck, of Baker Bros., Toledo, Ohio, writes that it is their belief that "multiple-spindle drill" should apply to machines of the Baush, Fox, "Natco" or cluster box type, and that "gang drill" should apply to single-spindle drilling machines connected in a gang.

TOGGLE FRICTION CLUTCH

H. W. L.—The two clutches shown roughly in Fig. 1 act on the toggle principle. What is the theory pertaining to the friction and forces acting on the bearing surfaces of such clutches? I have been unable to find any data of this kind.

Answered by John S. Myers, Philadelphia, Pa.

To illustrate the principle on which such clutches operate, refer to Fig. 2. Here, a block resting upon a smooth surface is acted upon by a force C. This surface reacts against the block with an equal force C_1, neglecting the weight of the block. Now force C may be resolved into a component N acting normal to the surfaces and a component F acting parallel to the surfaces. The resistance offered by friction opposing motion in the direction of the arrow is fN, where f = coefficient of friction. If this resistance is greater than the component F, no sliding of the surfaces will result. As $F = N \tan \alpha$, if we do not desire sliding to occur, $N \tan \alpha$ must be less than fN, or $\tan \alpha$ must be less than the coefficient of friction f.

The same principle applies to the clutch problem, and the forces there acting are indicated by similar letters in Figs. 3, 4 and 5. The function of the spring A, Fig. 1, is simply to keep the friction surfaces in contact, and the forces due to it as well as to centrifugal effect, being small, may be neglected. For example, suppose that it is desired to develop a twisting moment of 6000 inch-pounds with a radius R of 10 inches and a coefficient of friction $f = 0.08$; what are the forces acting? The frictional component must be $F = 6000 \div 10 = 600$ pounds. Taking $\tan \alpha = 0.06$, allowing 0.02 less than f

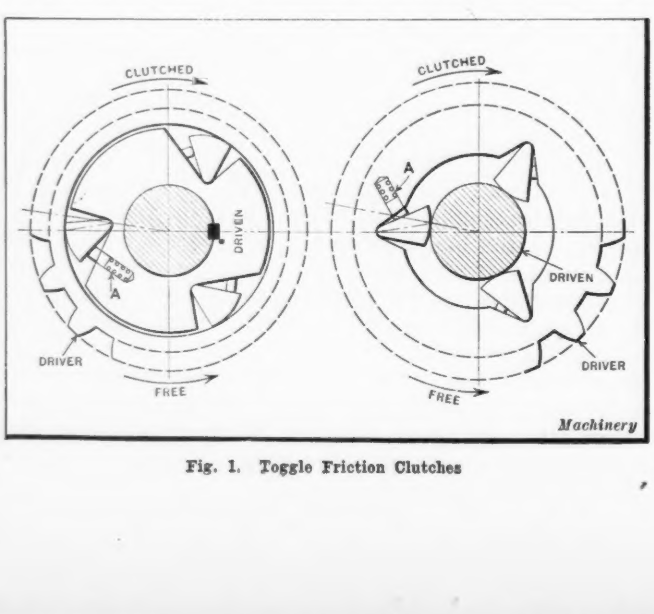
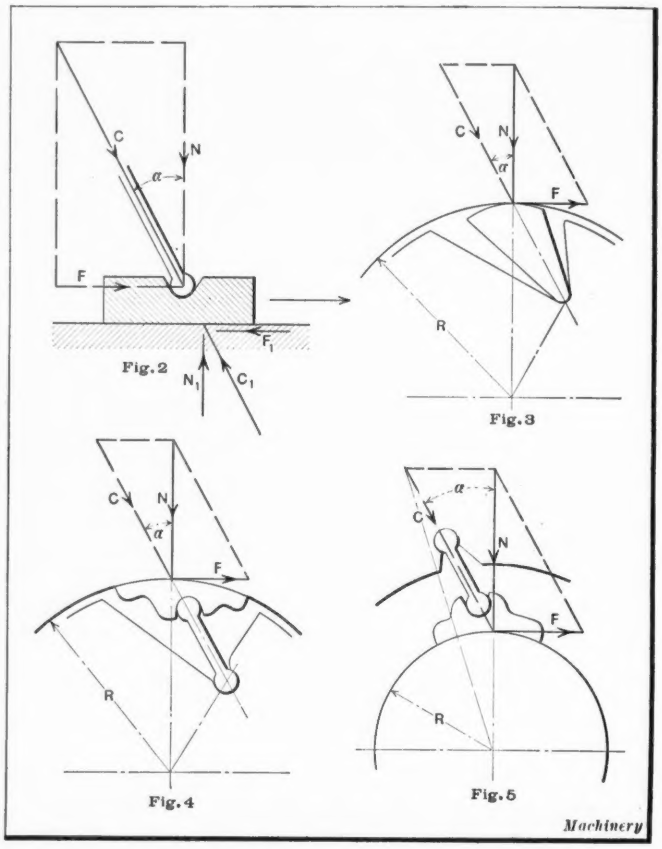


Fig. 1. Toggle Friction Clutches



Figs. 2 to 5. Diagrams showing Principles of Friction Clutches

as security against slipping, the force acting normal to the friction surfaces is $N = \dfrac{F}{\tan \alpha} = \dfrac{600}{0.06} = 10{,}000$ pounds, or $10{,}000 \div 3 = 3333$ pounds on each of the three surfaces. The various parts of the clutch would have to be sufficiently strong to withstand these forces. Problems allied to this are discussed in "The Constructor," by Reuleaux, pages 158 to 161. The wearing shoes indicated in Figs. 4 and 5 make no difference in the theory of the device, but increase its useful life by preserving the proper length of the toggle element.

* * *

CONCRETE MIXTURES

In a paper read before the Concrete Institute of Great Britain recently, it was stated that in a 1-2-4 concrete the cement may range from 18 to 24 per cent of the total volume of the mixture. For instance, 130 tons of dry cement is required for a broken-stone aggregate and only 100 tons when gravel is used. But the concrete containing gravel is from 12 to 15 per cent weaker than the one with the broken stone. However, when the quantity of cement per cubic foot of the mixture is the same, gravel concrete is as strong as concrete with a broken-stone aggregate. Washing the aggregate increases the strength of hand-mixed concrete 30 to 40 per cent, and of machine-mixed concrete, from 15 to 20 per cent. As the strength of concrete is governed largely by the percentage of cement that it contains, it has been suggested that specifications, instead of calling for a 1-2-4 mixture, provide that the volume of dry cement used be a specified proportion of the total final volume of the mixture.

* * *

A new type of soldering iron consists essentially of two high-resistance heating points, or electrodes, that become incandescent when the current passes through them. As the circuit is closed as soon as the points come into contact with the metal to be heated, the iron is said to become heated to the required degree the moment it touches the work. Besides, the heat is generated at the point of contact and at the spot where the heat is needed when soldering, brazing, or annealing. The iron operates at from six to sixteen volts and the points are made to carry current according to ratings of 150, 250, and 500 watts.

NEW MACHINERY AND TOOLS

THE COMPLETE MONTHLY RECORD OF NEW AMERICAN METAL-WORKING MACHINERY

LEEDS & NORTHRUP OPTICAL PYROMETER

This is an optical pyrometer for determining temperatures by the comparison of luminous hot bodies with a tungsten lamp filament in the pyrometer, which is adjusted by means of a rheostat until the brightness of the lamp corresponds to the brightness of the heated part as seen through the pyrometer. The reading of a milli-ammeter connected to the pyrometer enables the observer to determine the temperature with considerable accuracy, the readings of different observers for temperatures within the hardening range of steel varying not more than six degrees.

For the measurement of temperatures above, say, 1400 degrees F., only two methods have been found practicable for works service. One of these is based on the thermo-couple and the other on the laws of radiation. The latter includes both the radiation pyrometer and the optical pyrometer, which utilizes only that radiant energy visible to the human eye. For many services the inexpensive base-metal couple may be used for accurate measurements up to 2000 degrees F. with satisfaction; the more fragile and expensive platinum couple may be used up to 2800 degrees F., but the thermo-couple, like thermometers in general, must assume the temperature of the hot object by convection, conduction, radiation, or all combined. This fact militates against its use for measuring the temperature of molten brass, iron and other metals, or for measuring temperatures in gas producers and other locations where the thermo-couple would be subjected to rough mechanical treatment or to contamination by vapors and gases, which would rapidly impair its accuracy. In many industries the temperatures are far above the range of thermo-couples.

Measurements by radiation can be carried out at a distance when the laws concerning the temperature of radiating body and intensity of radiation have once been determined, and the radiation receiving and measuring part need not be heated to the temperature of the radiating body, nor even anywhere nearly to that temperature. Pyrometers utilizing radiation are divided into two classes: those which measure as heat energy the total radiation falling upon the receiving part

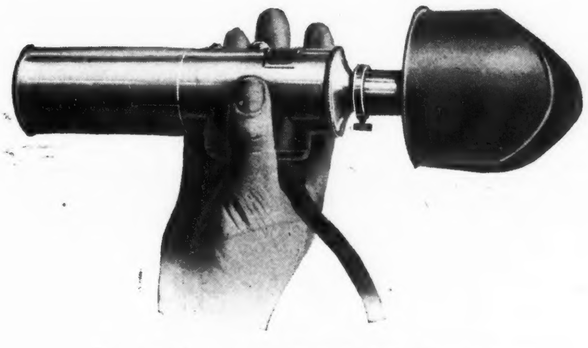


Fig. 1. Leeds & Northrup Optical Pyrometer

of the instrument, and those known as optical pyrometers, which are based upon the fact that the luminous radiation or light varies in a definite manner as the temperature of the hot body changes.

The greatest success has been attained by separating out one wave length of radiation—usually that which excites the sensation of red—and comparing the intensity of this one-color light with the intensity of the light of the same color emitted by a standard source of light. The eye is very sensitive when comparing the brightness of two surfaces when one is superimposed upon the other, and after having arranged to have light from the hot body and light from the standard of comparison viewed in this relation, they can be made equal, either by varying the amount of light received from the incandescent object or by varying the intensity of the standard of comparison. The latter method, that is, variation of the intensity of the standard of comparison, is preferred and used by the U. S. Bureau of Standards, also by the Reichsanstalt, of Berlin, where its practical application has been brought to a high degree of perfection by Messrs. Holborn and Kurlbaum. The Leeds & Northrup Co., of Philadelphia, Pa., working under the

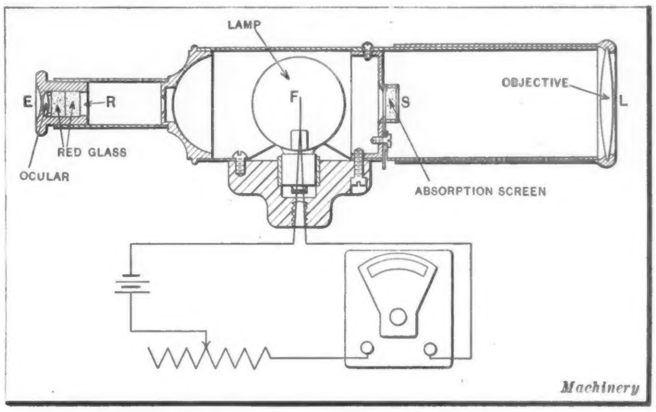


Fig. 2. Optical System and Electrical Circuit of Leeds & Northrup Pyrometer

fundamental Morse patents, has developed this type of optical pyrometer with a view to realizing a high degree of accuracy and reliability in a simple and portable device. The instrument, which is illustrated in Fig. 1, is suitable for measuring from dull red (about 1100 degrees F.) up to the highest known temperature.

The manner in which the luminous radiation from the hot body is balanced against that from a standardized source will be understood by reference to Fig. 2. By means of the lens *L*, rays from the hot body are brought to a focus in the plane *F*, where there is located a tungsten lamp filament. By means of the eye-piece *E*, the observer views the incandescent filament, which appears to lie upon the image, just as the cross-hairs in a surveyor's telescope appear upon the distant object looked at. By means of a rheostat in a case slung about the neck (see Fig. 3), the case also containing a storage battery and a milli-ammeter, the current through the lamp is adjusted until the brightness of the filament is just equal to the brightness of the image produced by the lens; that is, so that the filament blends with the background formed by the hot object. The observer then notes the reading of the milli-ammeter, which may be provided either with a special scale to read in degrees of temperature or the temperature corresponding to the current may be read from a calibration curve supplied with the instrument. The adjustment is made with accuracy, as the eye is keen in distinguishing differences in brightness between superimposed objects.

At high temperatures the light emitted by both the hot body and the filament would become dazzling, and comparison would be difficult. For this reason a red glass is placed in the eye-piece at *R*, which has the further advantage that light of only one color then reaches the eye and no difficulty is introduced by lack of color identity between the light emitted by the hot body and that emitted by the filament. The intensity of light radiation of any one color increases progressively in a definite manner as the temperature of the radiating body rises, and nothing is therefore lost by eliminating all other light from the comparison. As only brightness, not color, of light is matched, inability to distinguish colors and color-blindness do not interfere with the use of the instrument. In fact, in the range of temperatures used for harden-

Fig. 3. Method of using Optical Pyrometer

ing steel, for example, different observers using this instrument agree in their readings within 6 degrees F.

The brightness of the image of the hot body produced by the lens L is almost absolutely constant, irrespective of the distance from the hot body, although the size of the image varies with the distance. Since it is the brightness of the image and not the total radiation received through the lens that is measured, it is possible to measure the temperature of a small body or of a body at a distance equally as well as that of a large body or of one near at hand. It is not necessary that the hot body should fill the entire field of view of the instrument, as with "total radiation" pyrometers.

In observing bodies at very high temperatures, as 2500 degrees to 10,000 degrees F., the light received through the lens is too blinding for direct observation, even through the red glass of the eye-piece, and the intensity of the image might also become greater than that at which it is practicable to burn the tungsten filament, so that a balance would become impossible. Some method for reducing the intensity of the light must therefore be provided, such as by placing a screen to intercept some of the light. The screen is placed between the lens and the image so that it reduces the light from the hot body, but not that from the filament. With the reducing screen it is possible to make direct observations of the most brilliant light, as the electric arc or the surface of the sun.

It is not feasible to calibrate the instrument at such high temperatures by direct comparison, since they are above all known melting points and the ranges of contact thermometers, but fortunately a relation has been found to exist between temperature and intensity of radiation of any one color or wave length of light. By making use of this relation, known as Wien's law, and reducing the intensity of the image in a known ratio by means of the screen just referred to, it is possible to extend the scale of the instrument to the highest temperature. The scale thus obtained has been found to agree closely with a scale of temperatures established by known facts about the relation between temperature and total radiation. In other words, this form of optical pyrometer gives the same scale of temperature as do total energy pyrometers used with the precautions necessary to secure accuracy and precision in the measurement of total radiation. The screen used for cutting off part of the radiation from very hot bodies can be thrown into or out of the field of view by means of a milled disk projecting through an opening in the tube of the instrument. With the absorbing screen in use, a different milli-ammeter scale or calibration curve is required, but as the range of the instrument without the absorbing screen overlaps many hundred degrees with the range for the absorbing screen, the accuracy of the two scales can always be checked by observing a hot body, the temperature of which lies within this range.

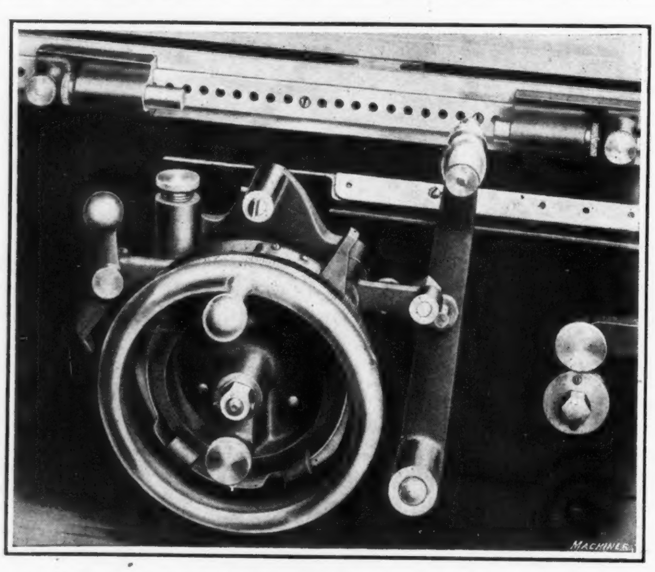
The readings obtained with this instrument are always the same for the same temperature, if the body viewed is surrounded by other objects, such as the walls of a furnace at the same temperature. Also no correction is required in the case of so-called "black bodies," such as incandescent carbon, when viewed in the open. For iron and steel in the solid state, the corrections required for readings taken in the open are also negligible. Objects having a metallic sheen, that is, a surface which reflects light freely, as molten metal or polished platinum, do not give the same readings when viewed in the open as when viewed in the furnace, or as a black body would give with this or any other radiation or optical pyrometer. The readings, however, are always consistent for the same material under the same conditions, and by using suitable reduction factors, can be converted to true temperatures. Furthermore, the readings obtained with this type of instrument when sighted upon a body in the open differ less from those given for the same body at the same temperature enclosed in a furnace, or for a black body at the same temperature, than do the readings of instruments which measure the total radiated energy. In other words, the correction where there is a departure from "black body" conditions is smaller than with the total radiation pyrometer.

The instrument can be calibrated by sighting it upon bodies the temperatures of which are known, either by means of a thermo-couple pyrometer, or by the melting or freezing of various substances. The constancy or reliability depends upon the constancy of the lamp, or its ability always to shine with the same intensity when receiving the same current. This matter has been investigated exhaustively by the U. S. Bureau of Standards and also in the laboratory of the Leeds & Northrup Co., and it has been found that after a tungsten filament is thoroughly aged, that is, burned for some time at a temperature higher than that to which it will be subjected in service, no sensible variation thereafter occurs. The instrument is so designed that one lamp can quickly be replaced by another, and by keeping two lamps, their correctness can always be insured by checking one against the other.

The instrument itself is handy and portable, weighing only a few ounces, and can be sighted as easily as an opera glass. The case, containing the battery, rheostat, and milli-ammeter, is slung about the neck, and weighs about ten pounds.

CROSS-FEED MECHANISM FOR OTT GRINDER

The Ott Grinder Co. of Indianapolis, Ind., has brought out a new design of universal grinding machine. The most notable feature of this machine is the automatic cross-feed mechanism,



Automatic Cross-feed Mechanism applied to No. 2 Universal Grinder built by the Ott Grinder Co.

which is shown by the accompanying detail illustration. In order to obtain simplicity and ease of adjustment, this mechanism has been equipped with a single rocker arm, a spring plunger and a stop-screw. When the table reaches the end of its stroke, the cross-feed rocker arm is swung down to its lowest position by a hardened pin on the reverse lever. As the table reverses its motion, the rocker arm is forced to move upward by a compressed spring. This upward movement continues until it is arrested by an adjustable stop-screw.

The pawl attached to the left-hand end of the rocker arm engages the cross-feed ratchet wheel, thus feeding the wheel slide. The feeding movement may be varied from 0.00025 to 0.003 inch. With this mechanism the grinding wheel is fed inward by the positive action of the reverse lever as it engages the rocker arm, whereas the spring previously referred to is simply relied upon to move the rocker arm and pawl back an amount depending upon the feed adjustment. The feeding movement may be disengaged by swinging over the feed pawl or by screwing down the adjusting stop. The feed may be disengaged automatically, a positive stop being provided for hand feeding.

METALWOOD STRAIGHTENING PRESS

The Metalwood Mfg. Co., Leib and Wight Sts., Detroit, Mich., is now manufacturing a straightening press in 20- and 35-ton sizes, and in three styles, including a motor drive, a belt drive from a lineshaft, and an accumulator drive. The particular press shown is equipped with a motor. The hydraulic pump for operating the press forms an integral part of the design and is of the two-plunger type. This pump is mounted upon the base, which forms a tank for the liquid. The pump body is of bronze, and the plungers are of tool steel, hardened and ground. The pump bearings are of phosphor-bronze. The ram of the press is returned by a heavy spring arranged for differential pull and with an adjustable tension. The ram nose has a sliding chrome-nickel steel resistance block with two steps for crank work, so as to reduce the stroke of the press whenever practicable and increase the operating speed.

The table is made of semi-steel and is provided with renewable steel strips upon which the centers are mounted and which take the thrust of the ram when pressure is applied to the part being straightened. The table is finished on the top and sides so that indicators can be used for testing the work. The centers are of the yielding type and are adjustable for length. The thrust is taken by tapered steel wedges placed under the work on the steel tracks. A single lever and a quick-operating valve serve to control the speed of the

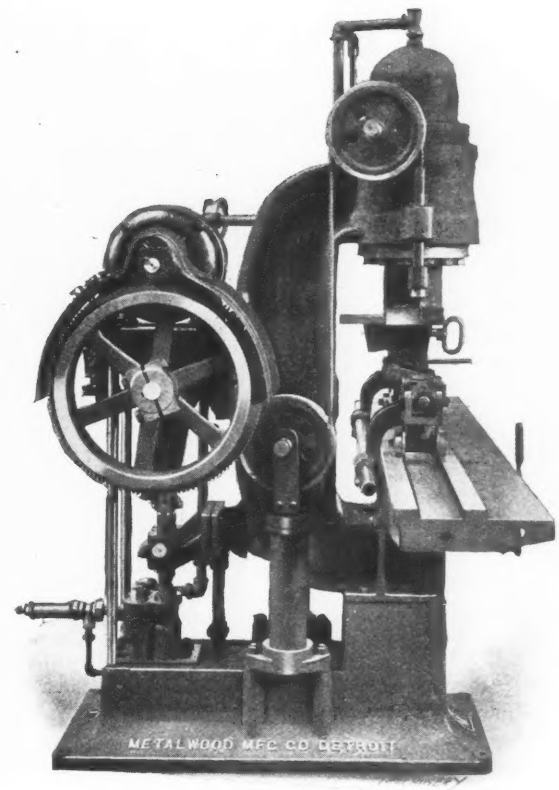


Fig. 2. Side View of Straightening Press

press ram, the pressure applied, and the return movement. All parts of the press subjected to heavy stresses are of alloy steel castings or forgings, and all piping under hydraulic pressure is of seamless steel tubing. The press is equipped with a gage reading in pounds per square inch and tons on the ram or applied to the work.

WESTINGHOUSE OVEN HEATER

An electrical oven heater designed especially for use in enameling or japanning ovens is illustrated herewith. This heater may also be applied for a variety of work where ovens are employed for a baking or drying process. The heating element consists of a ribbon wound on a number of fire-clay bushings assembled on two steel tie-rods, between two pressed steel end-plates. The ends of the ribbon are secured to drop-forged steel terminals, clamped to the steel tie-rods, which therefore become the terminals for the heaters. The tie-rods are insulated where they pass through the end frames, and the ends are threaded for bolting onto the connectors. Special

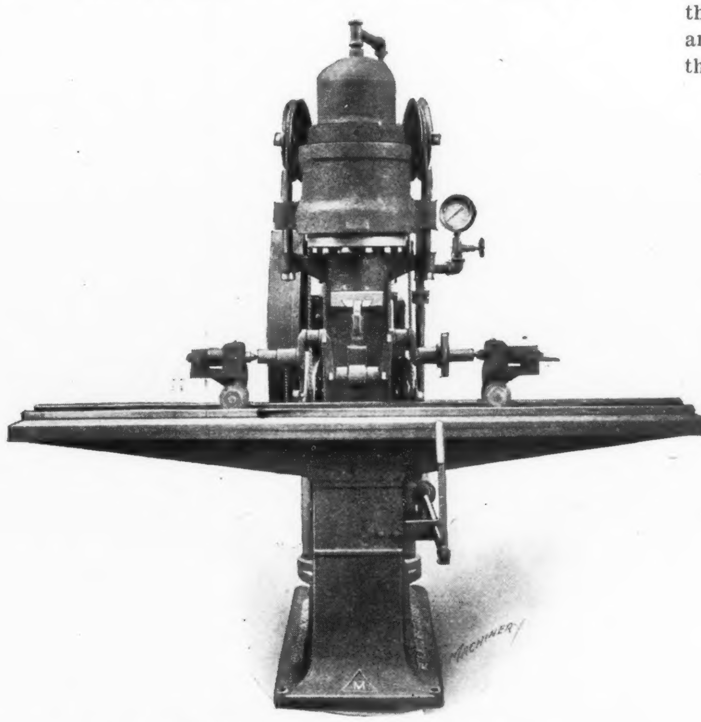
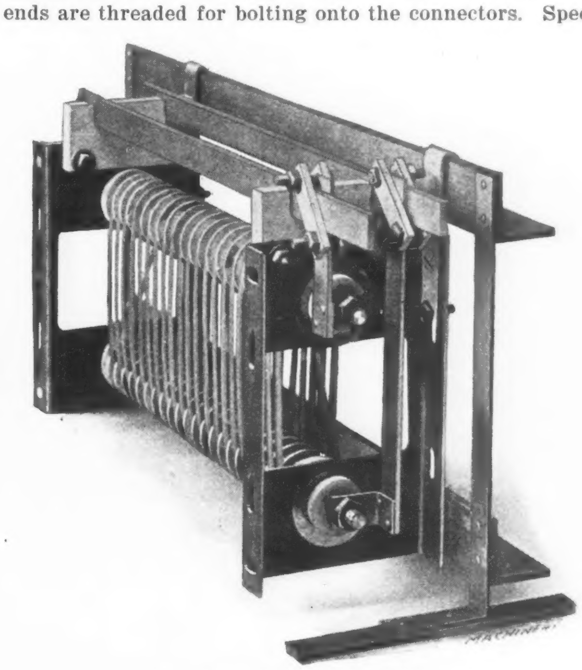


Fig. 1. Front View of Metalwood Straightening Press



Westinghouse Type C Oven Heater

connectors are furnished to meet requirements. Cold-rolled steel bus bars are recommended, and may be mounted directly above the heater on insulators bolted directly to the end-frames. Connectors are secured to bus bars by steel clamps.

Hooks are used for hanging the heaters from the usual supporting steel work, which may be flat iron, angle iron, channel iron or pipe work. The hooks are bolted to the flanged end-plates of the heaters. Protecting screens may be attached directly to the flanged end-plates without any other means of support. Heaters may be mounted either on the side walls or on the floor, and in any position.

These heaters are normally rated at 2.5 kilowatts at 120 volts. Any number of them may be installed in an oven, and connected to any power circuit, whether single-phase or polyphase and 110-220 or 440 volts. On 220-volt service, two heaters are connected in series, and on 440-volt service, four heaters are connected in series. Where three-phase power circuits are used, the heaters are connected three-phase, with the phases balanced. This heater (Type C) is made by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.

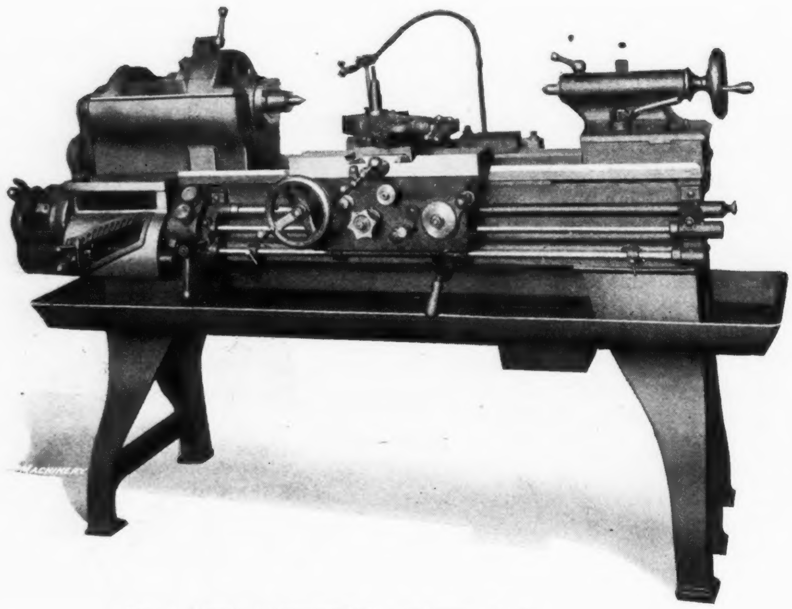


Fig. 1. Davis "Close-coupled" Tool-room Lathe

DAVIS TOOL-ROOM LATHE

The "close-coupled" tool-room lathe now being manufactured by the Davis Machine Tool Co., Inc., Rochester, N. Y., has been designed to meet modern requirements as to accuracy, convenience, power and simplicity of construction. Front and rear views of this machine are shown in Figs. 1 and 2, and a sectional view of the headstock in Fig. 3. One of the important features of this lathe is the method of mounting the "back-gears," which are placed under the headstock at the front end of the spindle. The small cone gear that is usually located at the end of the cone next to the small step is placed next to the large end of the cone. The back-gears are carried in a yoke which swings from a bearing at the back of the headstock. These gears are engaged with the cone gears by a cam operated from the front of the lathe by the small handle seen in Fig. 1 at the right of the gear-box. With this back-gear arrangement, the long eccentric shaft and quill common to cone-driven lathes, and the torsional strains to which this member is subjected, are eliminated.

The headstock is a heavy one-piece casting. Gear guards are integral with the headstock and form a cover for the cone pulley. At the top of the gear guard there is a brake for stopping the rotation of the spindle. This feature is of especial value when frequent inspection or gaging is necessary. The crucible steel spindle is mounted in heavy phosphor-bronze boxes, which are lubricated from large oil pockets by means of rings. The front spindle bearing is tapered to compensate for wear. The carriage has a bearing of 19¼ inches on the ways and a cross-bridge 6 inches wide. The compound rest is provided with four clamping bolts for holding it rigidly in any position.

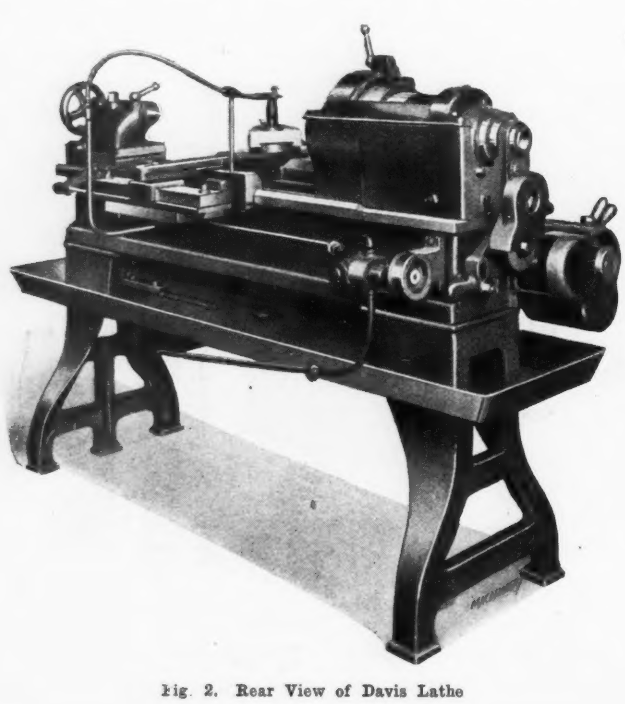


Fig. 2. Rear View of Davis Lathe

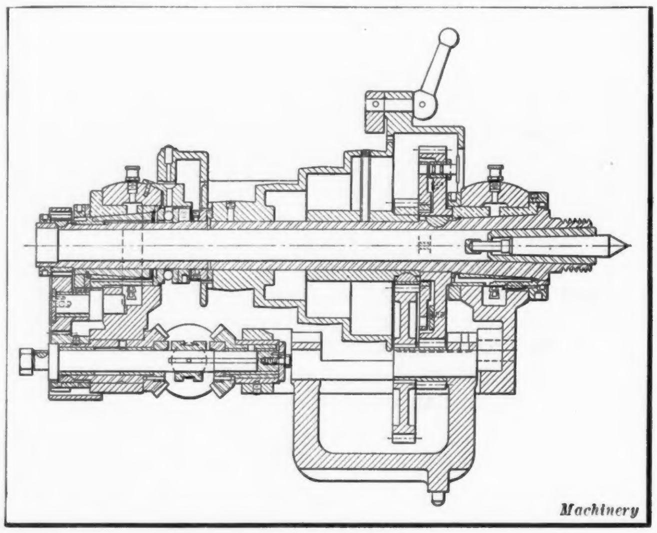
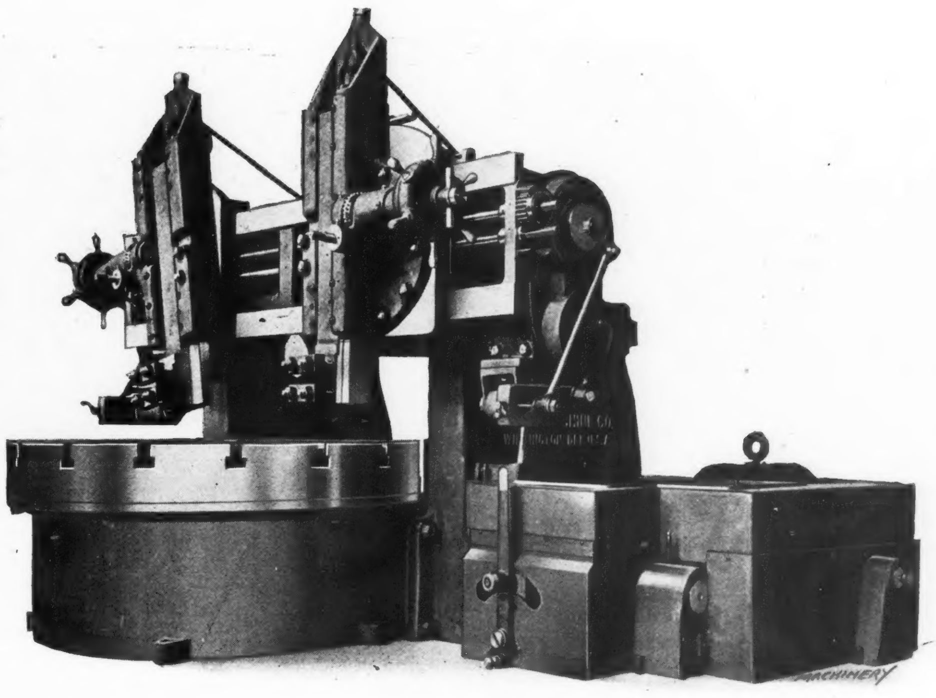


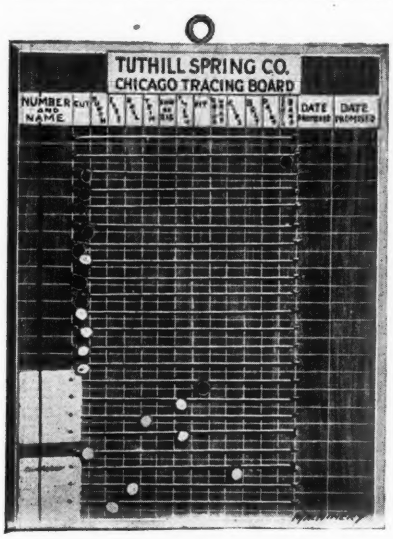
Fig. 3. Headstock of Davis Lathe

The apron is of the double-plate type with two bearing supports for all shafts. A central oil pocket is arranged to lubricate all bearings from one point. The apron has the usual interlocking feature to prevent engaging the feed-nut and half-nut at the same time. The lever seen in Fig. 1 beneath the right-hand end of the apron serves to reverse the movement of the carriage by shifting a sliding clutch interposed between bevel gears located beneath the headstock. The same rod that operates this reverse mechanism carries adjustable collars for stopping the feeding movement of the carriage at any point. This lathe has a screw cutting capacity varying from 1½ to 80 threads per inch, including 11½. The regular equipment provides thirty-six different leads or pitches, and this number can be increased by applying change-gears to the quadrant. The maximum error allowed in the lead-screw is 0.001 inch per foot. Thirty-six different feeds are provided, the feeding movement being transmitted through an independent feed-rod. All gears in the quick-change gear-box are made of steel and generated on a gear shaper.

To insure correct alignment, an extra foot is placed in the center of the right-hand leg, so that the lathe has a three-point support. The outer ends of the right-hand leg are provided with adjusting bolts which can be screwed down until they just touch the floor, thus overcoming any rocking tendency. The bed of this machine is ribbed transversely with heavy double-wall cross girths. The rear end is low enough to permit sliding off the tailstock without disengaging the clamping bar or removing bolts. The manufacturers will supply this machine with a motor drive if desired. The motor is mounted over the headstock and is geared to the spindle through a train of gears which provide four mechanical changes by sliding clutches. Further speed changes are obtained through the motor, which should have a variation of from 500 to 1500 revolutions per minute. This lathe may be equipped with a taper attachment, draw-in chuck and collets, transposing gears for cutting metric pitches, and a relieving attachment if desired by the purchaser.



Betts Tire Turning Mill



Board for following Progress of Orders through the Plant

TUTHILL SPRING CO.'S TRACING BOARD

The tracing of orders so that delays are noticed, the causes discovered, and deliveries made on schedule time, is a problem common with all manufacturers. Tuthill Spring Co., Kesner Bldg., Chicago, Ill., formerly followed the progress of orders through their plant by a card index system. Every day the exact location of each job was noted on a card, and the superintendent or shipping clerk was kept posted on just what was taking place by referring to the cards.

The tracing board, the upper section of which is shown in the illustration, was devised to facilitate this work. This particular board is used in tracing Chicago orders. Each day the entry clerk, in a much shorter time than it took to make the card records, can bring his tracing board up to date. A glance tells the superintendent, or anyone else interested, the exact status of each job.

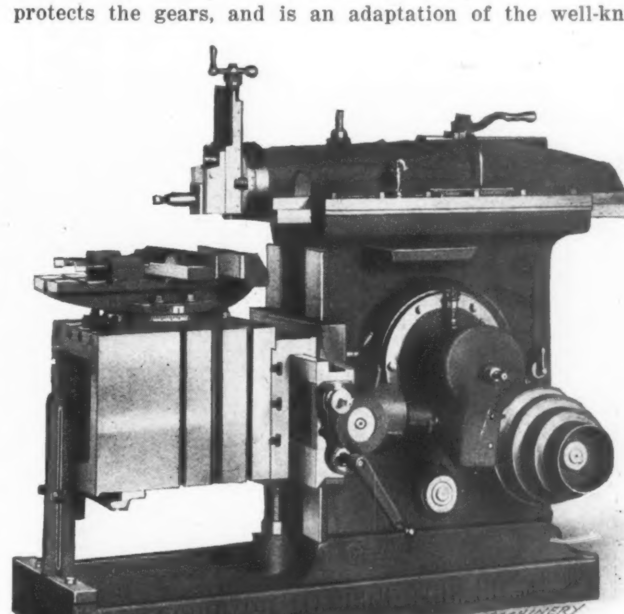
BETTS TIRE TURNING AND BORING MILL

A 66-inch tire turning and boring mill recently built by the Betts Machine Co., Wilmington, Del., is shown in the accompanying illustration. The machine swings diameters up to 72 inches and takes work 16 inches high under the saddles. It is driven by a twenty-five-horsepower electric motor. The general design of this machine is similar to that of a standard boring mill, but owing to the extremely severe duty for which the machine is intended, it has been made exceptionally strong. All driving gears are of steel, thoroughly covered, and provision is made to lubricate them properly; all feed gears, saddles and tool spindles are of steel, and the latter are independently counterbalanced and have rapid hand movement. Separate feed works are provided for each side of the machine, and the feeds can be changed quickly without stopping the machine.

The necessary speed changes are obtained through the field control of the motor in connection with two or three mechanical changes. This style of machine is built in five different sizes, ranging from 66 inches up to 108 inches, and it can be furnished with a movable instead of a fixed cross-rail so that it may be used for general machine shop work as well as for tire work.

COLUMBIA 20-INCH CRANK SHAPER

The heavy-duty crank shaper illustrated herewith is a 20-inch size built by the Columbia Machine Tool Co., Hamilton, Ohio. The column of this machine is made straight in front in order to permit the head to be set at an angle without interfering with its full travel across the table. The feed mechanism of this machine is designed along somewhat different lines from usual; it is carried in a housing which covers and protects the gears, and is an adaptation of the well-known



Columbia 20-inch Heavy-duty Crank Shaper

ratchet type. Feed changes may be made quickly, and a safety stop is provided, as well as means of controlling and indicating the direction of the feed. There are eight feed changes in all.

The position of the ram and the length of the stroke can readily be adjusted from the front of the machine. The ram is held in place by clamping gibs on top of the column, and an angular gib at one side of the ram provides adjustment for wear. The tool-head has a micrometer adjustment and is graduated for angular adjustment. The machine is provided with back-gears, which, in connection with the four-step driving cone pulley, give eight speed changes in geometrical progression. The table is of box form and long enough to accommodate work up to the full rated capacity. In addition to the regular T-slots, a V-groove is formed in one side of the table for holding round stock. The vise regularly furnished is of the double-screw type and has a graduated swiveling base.

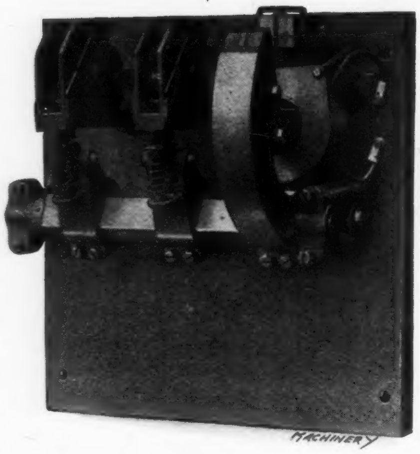


Fig. 3. Magnetic Contactor Panel

Fig. 4. Gage Type Pressure Regulator

WESTINGHOUSE AUTOMATIC STARTERS FOR INDUCTION MOTORS

Several automatic starters for motor-driven machinery, (manufactured by the Westinghouse Electric & Mfg. Co., East Pittsburg, Pa.), are shown in Figs. 1 to 4 inclusive. These automatic starters are for use with single-phase or polyphase squirrel-cage and wound-rotor induction motors, where it is desired to start the motor from a remote point or where automatic acceleration is required to guard against improper starting by unskilled operators. They are simple, reliable, and rugged in construction, consisting of a magnetic contactor panel and a master switch, which may be either a push-button, a float switch, a pressure regulator, or similar device for closing the control circuit, depending upon the service. The vital element is the magnetic contactor. The contactors used on these starters have been employed successfully in steel mill, cement plant, and mine installations, where the requirements are extremely severe. The contactors are opened by strong spring action assisted by gravity. The destructive action of the arc is reduced to a minimum by strong blow-out coils and arcing horns.

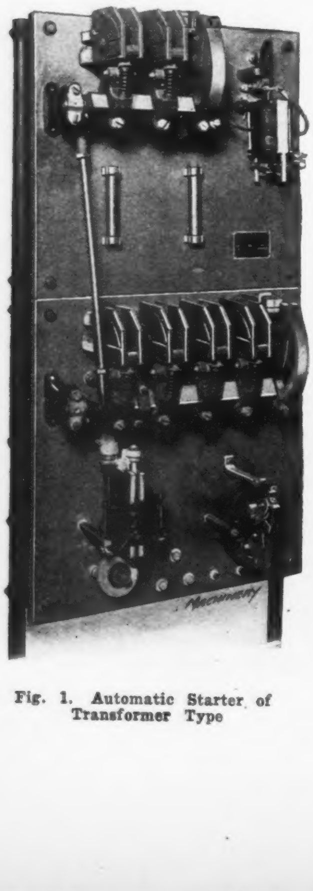


Fig. 1. Automatic Starter of Transformer Type

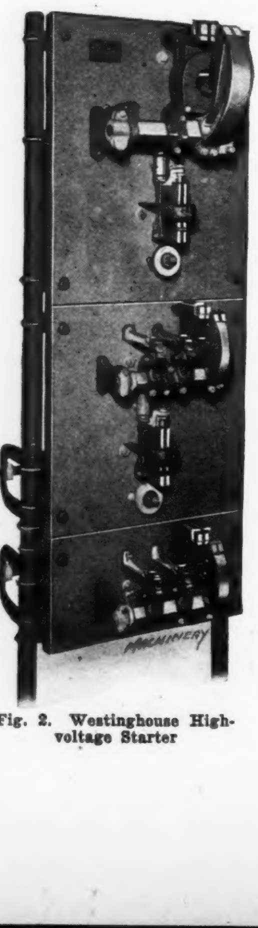


Fig. 2. Westinghouse High-voltage Starter

The operation of the starters is very simple. When starting motors driving lineshafting, woodworking, and machine tools, and similar apparatus, it is only necessary to press a button, and close a small knife or snap switch. The starter then automatically makes the proper connections to limit the starting current to a suitable value and to vary the time required for acceleration according to the load on the motor, thus preventing damage to the machinery by too slow or too rapid acceleration, and saving time by bringing the motor to full speed at the most rapid permissible rate. When used for pump or compressor service in connection with a float switch or pressure gage, the action of the starters is entirely automatic, the motors being started when the pressure or liquid level of the tank control falls to a predetermined point, and stopped when the desired maximum pressure or level is reached, or *vice versa*.

The automatic starters for squirrel-cage motors are most frequently employed for starting motors operating centrifugal pumps, air compressors, fans, blowers, metal-working and wood-working machines, and other apparatus requiring starting torque less than full load torque. This type of starter, however, owing to the wide application of squirrel-cage motors for industrial service, can be applied economically for starting service in nearly every industry.

Squirrel-cage motors of five horsepower and smaller are usually connected direct to the line. Large squirrel-cage motors are first impressed with low voltage from auto transformers or connected to the line through resistance so that in either case the starting current is reduced. When the speed of the motor has reached such a point that the starting current has decreased sufficiently the motor is then automatically connected to the line.

The automatic starters for wound-rotor motors are particularly adaptable for starting motors driving plunger pumps, positive pressure blowers, air compressors, long lineshafts, and loads having heavy inertia. The severe starting conditions encountered in this class of service require from 100 to 200 per cent full load torque in starting, making automatic starting a very desirable feature.

When an automatic starter is used in connection with a wound-rotor motor, the line switch is first closed, with the maximum resistance in the rotor circuit. When the speed falls to a predetermined value, a relay closes a magnetic contactor which cuts out a part of the resistance in the rotor circuit. Each contactor operates in a similar manner, cutting out its portion of the resistance at the proper time until all the resistance is short-circuited by the last contactor.

The power on any circuit may fail suddenly, and it is important that some protection be afforded both operator and motor against an unforeseen return of power. This protection may be provided for motors operating pumps, compressors, etc., by a low-voltage release to disconnect the motor from the line when the voltage is low or the power fails entirely. Then as soon as the power returns, the motor will automatically start up again. In many applications, however, such as for motors operating machine tools or wood-

working machines, low-voltage protection is required. Motors so protected are disconnected from the line when the power fails and will not start when the power comes on again until the operator presses a button or manipulates a similar device; hence, there is no danger from the unexpected starting of a machine.

The advantages resulting from the use of automatic starters for induction motors comprise absolute protection to both operator and machinery, proper starting at the most rapid permissible rate, economy in operation and maintenance, convenience of remote control, and automatic operation.

FOX ARBOR PRESS

The Sunderland Machinery & Supply Co., 1006-1010 Douglas St., Omaha, Neb., has placed on the market an arbor press known as the Fox "high-speed" No. 4, that is designed for rapid operation and adjustment. The press is equipped with a special type of mechanism for elevating and lowering the table easily and rapidly. The table is counterbalanced by a weight at the rear of the press so that it can easily be raised or lowered. It is elevated by grasping the handle at the left-hand side and simply lifting it, and is held in position by the rack and pawl shown beneath it. In order to lower the table the pawl is first disengaged from the rack by a lever provided for that purpose, and the table is then pushed down to the required position. The press ram is operated by a counterweighted ratchet lever, as the illustration shows. The frame and table are of cast iron, and the rack, pinion, pawl and ratchet are made of a special alloy steel properly heat-treated. This press will take diameters up to 19 inches, and the capacity over the table is 30 inches. The ram has a movement of 17 1/7 inches and the leverage is 60 to 1. The weight of the press is 1100 pounds.

Fox No. 4 Arbor Press

SKELTON TAPER REAMER

The taper reamer shown in Fig. 1 is designed for reaming taper holes and has a flat, high-speed steel blade and a low-carbon steel holder. The edge *A*, Fig. 2, is ground to a circular form, and between this edge and the heel *B* there is a flat surface. The heel is backed off or relieved sufficiently to allow for the maximum cut and still prevent "hogging in," the depth of cut being positively controlled by the clearance or amount ground away at *B*. The curved flutes *C*, adjacent to each cutting edge, provide rake so that the reamer cuts the metal instead of scraping it. The method of holding the blade allows for lining up the reamer with the spindle in case the turret hole is out of alignment. As Fig. 2 shows, the end of the holder is split and it has a circular tongue which engages a circular groove extending across the end of the reamer blade. The tongue is offset slightly with reference to the groove in the blade so that the blade is forced back into the bottom of the slot, thus aligning it with the holder. The clamping screw is of nickel steel, heat-treated and so arranged that the pressure comes in front of the holder. This reamer has been placed on the market by Charles E. Skelton, 107 N. Franklin St., Syracuse, N. Y.

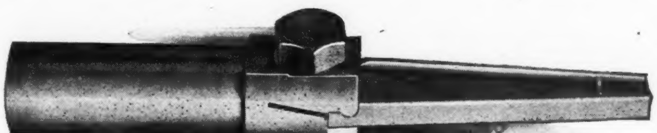


Fig. 1. Skelton Taper Reamer

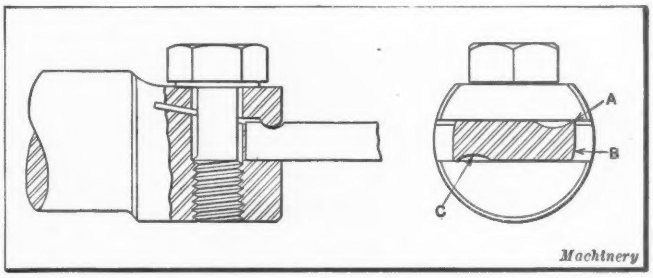
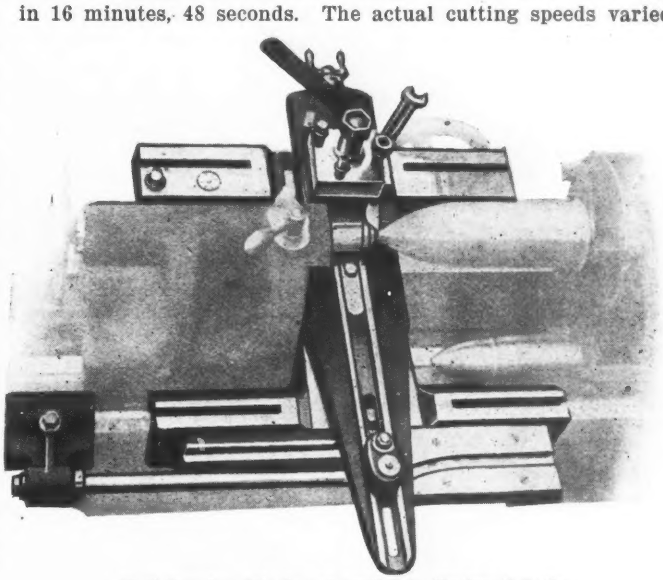


Fig. 2. Connection between Blade and Holder of Skelton Reamer

SHELL FORMING ATTACHMENT FOR CINCINNATI LATHES

An attachment for use when turning shells is shown in the accompanying detailed view as applied to one of a number of 18-inch lathes built by the Cincinnati Lathe & Tool Co., 3207-3211 North St., Oakley, Cincinnati, Ohio. A shell made of 50-point carbon steel, having a 12-inch radius, was finished to the required size and form with an attachment of this type in 16 minutes, 48 seconds. The actual cutting speeds varied from 69 to 204 feet per minute, owing to the curvature of the shell, and a feed of 1/32 inch was used. The attachment illustrated is equipped with a cam for forming 6-inch shells.



Shell Forming Attachment applied to Cincinnati Lathe

ARMSTRONG-BLUM METAL-CUTTING BAND SAW

A universal metal-cutting band saw, which is the product of the Armstrong-Blum Mfg. Co., 343 N. Francisco Ave., Chicago, Ill., is shown in a vertical position in Fig. 1, and in Fig. 2 with the saw blade tilted to an angle of 45 degrees for cutting an 18-inch beam. The saw may be inclined to a 45-degree angle, either to the right or left, and its position is indicated by suitable graduations. The saw blade is mounted on two flanged wheels supported by a rigid frame, which is pivoted to a frame or cage under the table. This cage is equipped with four hardened roller bearings that travel in planed dirt-proof races. The automatic feeding movement may be engaged or disengaged by means of a small lever at the front of the machine.

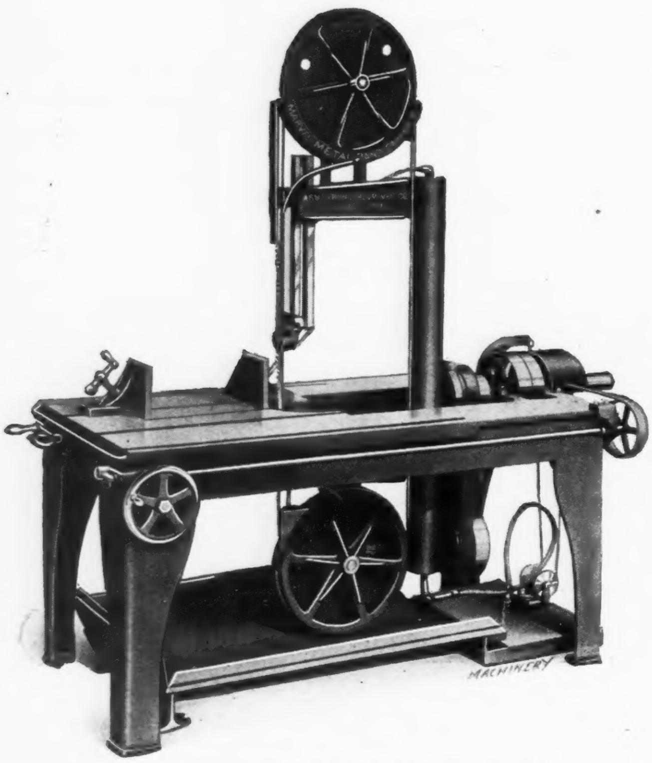


Fig. 1. Armstrong-Blum No. 8 Metal-cutting Band Saw

The required pressure is imparted to the saw blade by a bronze worm-gear having cork inserts, two friction disks, a spring and an adjusting nut. Lubrication is supplied to the saw blade at the cutting point by a submerged centrifugal pump, the lubricant passing directly through the teeth at the point of delivery. The saw blade guide rollers have double ball bearings and felt dirt-proof rings. The machine may be stopped at any required depth of cut by a knock-off dog or trip. The saw table is 32 inches wide, 5 feet long, and has four T-slots. The two inner slots are machined and notched to receive the vise jaws, which may be placed wherever needed or be removed entirely. The drip-pan is telescopic and designed to catch the lubricant when the saw blade is inclined 45 degrees either way from the vertical. The speed of the saw may be increased about 90 per cent by means of double cone pulleys. This machine has a throat capacity of 18 by 20 inches. The saw blade is 14 feet, 8 inches long, 5/8 inch wide, and 0.032 inch thick. Guards are provided wherever necessary.

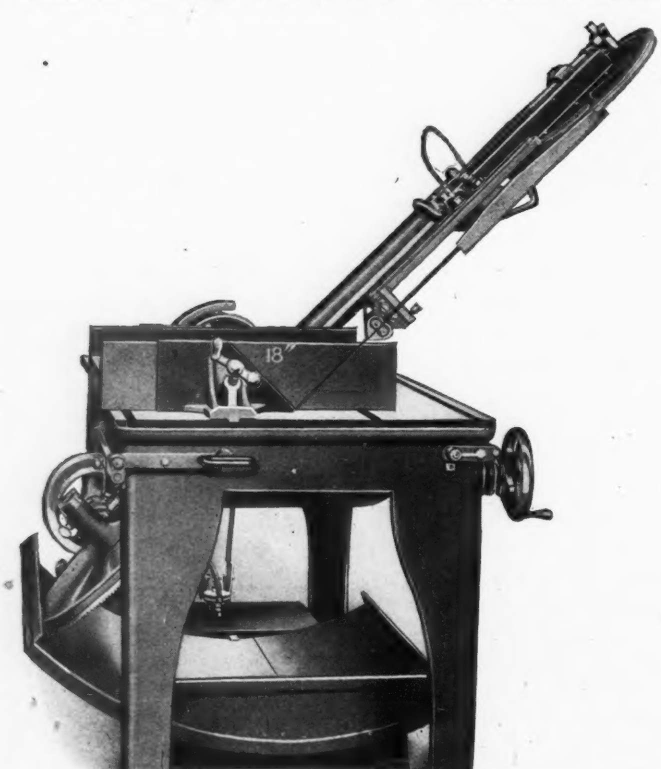
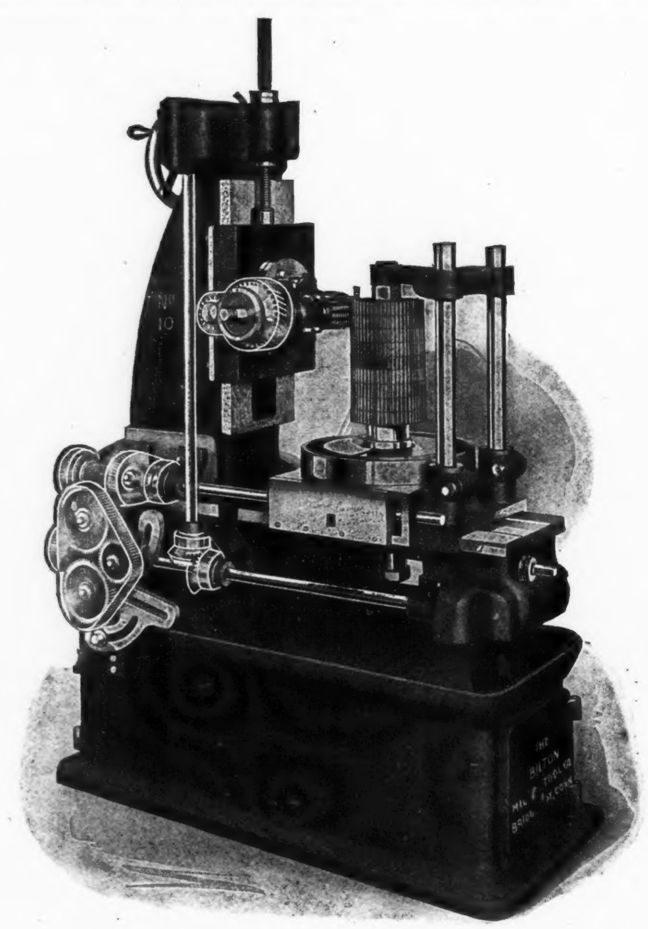


Fig. 2. Metal-cutting Band Saw set at Angle of 45 Degrees for cutting 18-inch Beam

BILTON UNIVERSAL GEAR-HOBBING MACHINE

A universal gear-hobbing machine recently added to the gear-cutting equipment of the Bilton Machine Tool Co., Bridgeport, Conn., has a rated capacity for gears of 10 inches outside diameter, 10 diametral pitch and 10 inches width of face. The work-table of this machine (see accompanying illustration) is driven through a steel worm and a bronze worm-wheel 11½ inches in diameter. The worm is automatically lubricated and is fitted with a ball thrust bearing. Automatic stops are provided for the vertical and horizontal feeding movements, and the horizontal feed shaft has a micrometer dial. The differential gears and the feeding and indexing gears, which are on the rear end of the machine, all have teeth of 14 diametral pitch, so that they are interchangeable, and the total number is reduced to a minimum.

The vertical slide is made extra long and has flat ways with large bearing surfaces. The hob spindle head carried by this slide may be set at any desired angle for cutting right- or left-



Bilton No. 10 Universal Gear-hobbing Machine

hand spirals. The hob spindle is driven through helical gears, and it may be adjusted lengthwise to relocate the hob if it should become dull in one place, without disturbing the adjustment of the spindle bearings. The work-table has a central hole 1⅜ inch in diameter, so that teeth can be hobbed on the ends of shafts up to 1⅜ inch diameter and 24 inches long. The table has deep oil-grooves with a drain running to the base of the machine where the oil reservoir is located. This reservoir is removable so that it can be cleaned. The hob speeds vary from 50 to 250 revolutions per minute and the range of hob feeds per revolution of the work is from 0.010 to 0.125 inch. The machine is driven through a three-step cone pulley designed for a 2½-inch belt. The net weight of the machine is 1100 pounds.

UNITED STATES ELECTRICAL GRINDER

The United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, Ohio, is now building a combination wet and dry grinding machine that is electrically driven. This grinder is built in two sizes, with motors of three and five horsepower capacity. The machine equipped with a three-horsepower motor is arranged to carry two grinding wheels 12 inches in diameter by 2 inches face width, and the five-horsepower machine carries two grinding wheels 18 inches in diameter by 3 inches face width. These grinders are equipped with either direct-current motors for 110-, 220- or 550-volt circuits or alternating-current motors for 220-, 440- or 550-volt circuits of 25 or 60 cycle and two or three phase.

The bearings used in these machines are of the self-aligning ball bearing type, and the motors are built by the Westinghouse Electric & Mfg. Co. The grinding machine equipped with a three-horsepower motor weighs 575 pounds, and the

United States Electrical Grinder

machine equipped with a five-horsepower motor weighs 700 pounds. The speed of the grinding machine driven by a three-horsepower motor is 1800 revolutions per minute, and the machine driven by a five-horsepower motor runs at 1120 revolutions per minute.

NEW MACHINERY AND TOOLS NOTES

Plug Gages: Simplex Tool Co., Woonsocket, R. I. A standard line of hardened tool steel plug gages varying by 1/32 inch from 1/8 to 1 inch in diameter.

Cutter Grinder: Elmer Sacrey, 1001 Diamond St., Philadelphia, Pa. A grinder for sharpening milling cutters up to 9 inches in diameter. The machine is equipped with a diamond wheel-truing device.

Pneumatic Hammer: H. Edsil Barr, Erie, Pa. This hammer strikes a maximum of 200 blows a minute and has a capacity for stock up to 2 inches square. The hammer is arranged to permit continuous striking.

Engine Lathe: Richard H. Kiddle, Kinsman, Ohio. Fourteen-inch engine lathe of cone pulley type, with beds varying from 4 to 10 feet in length. The swing over the carriage is 8 3/4 inches, and the weight, 1200 pounds.

Grinding and Polishing Stand: Lamb Knitting Machine Co., Chicopee Falls, Mass. A ball bearing grinding, polishing, and buffing machine. The head is separate from the base so that the machine may be used either as a bench or pedestal type.

Grinding and Buffing Stand: U. S. Electrical Mfg. Co., Los Angeles, Cal. This is a self-contained, motor-driven tool equipped with ball bearings that are sealed against dirt and grit. The machine may be supplied for bench mounting or with a pedestal.

Hydro-pneumatic Press: Metalwood Mfg. Co., Leib and Wight Sts., Detroit, Mich. A press for subjecting high-explosive and shrapnel shells to internal pressure. Presses of this type are built in various sizes with pressures ranging from 2000 to 21,000 pounds per square inch.

Bender for Ship Frames: Watson-Stillman Co., 192 Fulton St., New York City. Hydraulically-operated bender designed for bending heavy steel ship frames, deck beams, etc. The machine is mounted upon broad rollers so that it can be moved along the work when bending long parts to the shape of a templet.

Polishing Machine: Harvard Machine Co., Harvard Square, Cambridge, Mass. Polishing and lapping machine provided either with a No. 2 Morse taper spindle or with spring chucks for accommodating work up to 1/2 inch in diameter. These machines are intended especially for tool-room use in lapping bushings, plug gages, etc.

Pyromagnetic Indicator: Pyromagnetic Instrument Co., 175 N. Jefferson St., Chicago, Ill. An instrument of the magnetic type for determining the critical point when heating steel parts for hardening. One end of the instrument is energized and is placed in contact with the steel, which is heated until it becomes non-magnetic.

Universal Curveograph: W. G. Classon, Leominster, Mass. An instrument for the use of engineers and draftsmen, adapted for drawing simple, compound, reverse, and irregular curves. The spline or part for guiding the pen or pencil is held by adjustable fingers provided with graduations indicating the radius of curvature.

Automatic Threading Lathes: Automatic Machine Co., Bridgeport, Conn. These lathes operate on the same general principle as those formerly manufactured, but differ in some of the details. They are adapted for single or multiple thread cutting on either right- or left-hand screw threads. Forged tools or circular form cutters may be used.

Two-spindle Milling Machine: Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. A machine of the type having a horizontal planer type table equipped with two spindles, one being vertical and the other horizontal. The maximum height under the vertical spindle is 36 inches, and the width between the uprights, 42 inches.

Vertical Bending Rolls: Southwark Foundry & Machine Co., Philadelphia, Pa. A large bending roll for boiler plates having rolls which are vertical instead of horizontal. Two of the three rolls in the set are 22 inches in diameter, and the third roll is 30 inches in diameter. The driving motor and mechanism is located in a pit beneath the floor.

Cold Saw: Newton Machine Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa. A cold metal-cutting saw for handling heavy structural steel sections. The machine is equipped with a 56-inch saw blade, but this may be increased to 62 inches in diameter if necessary. With the smaller blade the machine will handle rounds up to 16 3/4 inches, squares up to 15 1/2 inches, and oblong sections up to 17 by 58 inches.

Power Shear: Buffalo Forge Co., Buffalo, N. Y. A line of power cut-off shearing machines. These shears are mounted on wheels to make them portable, and individual electric motor drive makes the entire machine self-contained. Four sizes of shears are built, the largest of which has a capacity for cutting flat bars up to 1 1/8 by 5 inches, round stock up to 1 3/4 inch in diameter, square stock up to 1 1/2 inch, and angles up to 5 by 5 by 9/16 inch.

Spline Milling Attachment: Standard Engineering Works, Pawtucket, R. I. An attachment of the vertical type for use on hand and weight-fed milling machines. It is adapted for milling tang slots, feather keyways, etc. A cam operated by a ratchet gear controls the vertical movement of the cutter, and the spindle returns to an upright position automatically after reaching the proper depth. The horizontal travel is controlled by an automatic trip.

Sandblast Room: American Foundry Equipment Co., 52 Vanderbilt Ave., New York City. A compartment for the protection of the operator when sandblasting. The compartment or room has a circular table which extends beyond the enclosed part at the rear, so that it can be loaded while the work inside the compartment is being operated upon. The sandblast nozzle is inserted through a slit covered with rubber flaps, and the work may be seen through a fine brass screen.

Power Press Guard: G. H. Scott Machine Co., Cleveland, Ohio. This guard is entirely independent of the press treadle. Accidents due to repetition of the press are claimed to be impossible, and it is also stated that interference with the production of the machine is avoided, as well as accidents to the dies and the press. The guard is actuated by a cam and roller, and descends ahead of the ram, but the work is visible at all times and the operator has free use of his hands.

Dynamic Balancing Fixture: N. K. Akimoff, 1013 Harrison Bldg., Philadelphia, Pa. A fixture applied to an engine lathe for testing the dynamic balance of revolving machine parts. One end of the part to be tested is held in the chuck while the other rests on rollers having a yielding support. The position of an adjustable member is changed until an indicator dial shows that the part is in balance. The amount and location of excess metal to be removed by drilling is determined by reference to special tables.

Wire Nail Machines: Sleeper & Hartley, Inc., Worcester, Mass. Distinctive features of these machines consist of the employment of toggle joints actuated from a single crankshaft to provide the working motions, separation of the pointing and heading operations, and reduction in the size and weight of the machines and the floor space which they occupy. In operation, wire is taken from a coil and run through straightening rolls. During a single revolution the wire is fed forward to form the nail blank, the blank is cut off and the incoming end pointed. In the meantime the previously cut-off blank is headed.

* * *

MR. SHIPLEY RETIRES FROM THE LODGE & SHIPLEY MACHINE TOOL CO.

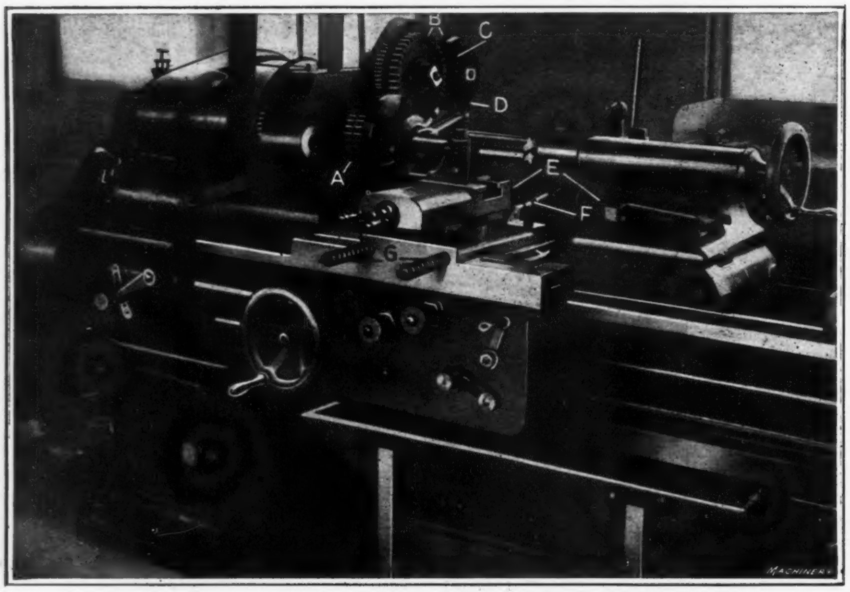
Mr. Murray Shipley has sold his holdings in the Lodge & Shipley Machine Tool Co. of Cincinnati to Mrs. Lodge and her daughters, and given up all connection with that business. Mr. Shipley states that his retirement from the company does not necessarily indicate a permanent retirement from business, but rather a relief from the close attention which he has had to give to details for twenty-five years. Mr. Shipley has been identified with the concern since its establishment by Mr. Lodge and himself in August, 1892, and his activity in the machine tool business has covered a period of great progress and expansion in the industry, of which the Lodge & Shipley Machine Tool Co. has had its full share, starting from a small shop on Culvert St., from which it was moved to its present location, where the plant and business has steadily increased until it is now one of the largest and best known in the world. The new officers of the company are Mrs. M. G. Lodge, president; J. W. Carrel, vice-president and general manager; and L. A. Hall, secretary and treasurer. It is stated that the policy and organization of the company will continue on the same progressive lines as before. J. W. Carrel, the vice-president and general manager, has had many years of training and experience in the manufacture and sale of machine tools, having been connected with several well-known concerns before he became sales manager for the Lodge & Shipley Machine Tool Co. Mr. Carrel is widely known and highly regarded in the industry, and under his management the business will undoubtedly continue moving onward and upward.

* * *

RELIEVING ATTACHMENT FOR LATHE

The Phoenix Mfg. Co. of Eau Claire, Wis., has equipped one of its engine lathes with a simple attachment for relieving hobs, taps and various forms of milling cutters. It will be seen that this consists of a gear *A* mounted on the lathe spindle nose, from which power is transmitted to compound gears *B*, carried on a bracket at the back of the lathe. These compound gears may be changed to suit the cutter that is being relieved. Secured to the last gear of the compound train there is a cam *C* which has the same number of lobes as there are flutes in the cutter. A roller mounted at the end of crank *D* runs in contact with cam *C*, and is secured to an eccentric shaft *E* mounted in bearings at the back of the lathe bed.

By disengaging the cross-feed screw in the lathe carriage, the cross-slide is left free and connection is made between it and the eccentric on shaft *E* by means of a connecting-rod *F*. It will be apparent that cam *C* and crank *D* impart an oscillating movement to eccentric shaft *E*, from which a corresponding reciprocating movement is imparted to the cross-slide on the carriage. In this way the necessary motion is obtained to give the cutter teeth the required relief. Different cams *C* and combinations of compound gears *B* are employed according to the type of cutter that is to be relieved. Cam *C* must, of course, have the same number of lobes as there are flutes in the cutter. Springs *G* hold the cross-slide so that all lost motion in the mechanism is taken up and accurate results are secured. E. K. H.



Lathe Attachment for relieving Milling Cutters, Taps and Hobs

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"COLLEGE OF THE MIDNIGHT LAMP"

BY GUY H. GARDNER [1]

Though not wholly unfamiliar with other institutions of learning, I hold high opinions of the "College of the Midnight Lamp." Just now I have a small yarn to spin in regard to it. Last November a young apprentice wrote asking me to tell him how to find by a lay-out, as he knew no mathematics beyond long division, how far apart to place the tacks to draw an ellipse 8 by 12 inches. I learned subsequently that he wished to make a hole for an 8-inch stovepipe. In the last week of November he began the "midnight" study of plane geometry. In January of this year he began trigonometry. March 24, in response to his request for "something a little harder," I sent him a trigonometric problem which I have put before successive generations of high school and academy boys without finding one who could solve it. It is simple, but depends on the formula for the sine of twice an angle. My apprentice friend sent me the solution by return mail. Rah for the "College of the Midnight Lamp!" He is now working on the mathematics of gearing, and asks me to help him later with navigational astronomy, as he thinks "a man ought to have a hobby unconnected with his daily work."

His father writes that he has never seen so marvelous a transformation of character. No more loafing, no more "movies," just hard work, which is not hard because he loves it. That boy will amount to something. I could tell a dozen tales of men who have subscribed to MACHINERY to get rid of an importunate solicitor, and have undergone, in consequence, as complete a change of character as this youngster. Billy Sunday "has nothing on" MACHINERY as an agent of reformation.

* * *

GRINDING WHEEL BALANCE

Howard W. Dunbar calls attention to the need of perfect grinding wheel balance in *Grits and Grinds*, asserting that probably nine-tenths of all trouble with cylindrical grinding machines is caused by the efforts of the operator to obtain good work by tightening the boxes so as to prevent an out-of-balance wheel causing marks on the work. Out-of-balance wheels set up vibrations throughout the whole machine, which cause chatter marks in the work; they are more likely to break than wheels in balance; they wear out the spindle boxes rapidly; and are more destructive to diamond truing tools, requiring more frequent dressing. Out-of-balance wheels, therefore, are more expensive than wheels in balance because of more rapid wear and their deteriorating effect on grinding machinery.

[1] Address: New London, N. H.

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SPOT-FACING TOOLS

BY F. B. JACOBS[1]

Spot-facing tools and counterbores are often spoken of as the same thing, but there is a slight difference between them. As a general thing, a spot-facing tool is used to finish off a surface, although it is sometimes used to counterbore a hole slightly. On the other hand, a counterbore is generally used for counterboring comparatively deep work and sometimes for enlarging a hole that has been drilled, particularly when several holes are so near together that they break into each other. There are many varieties of spot-facing tools, but this article will be confined to some of the more simple forms that have been found efficient in everyday work, especially in the automobile industry.

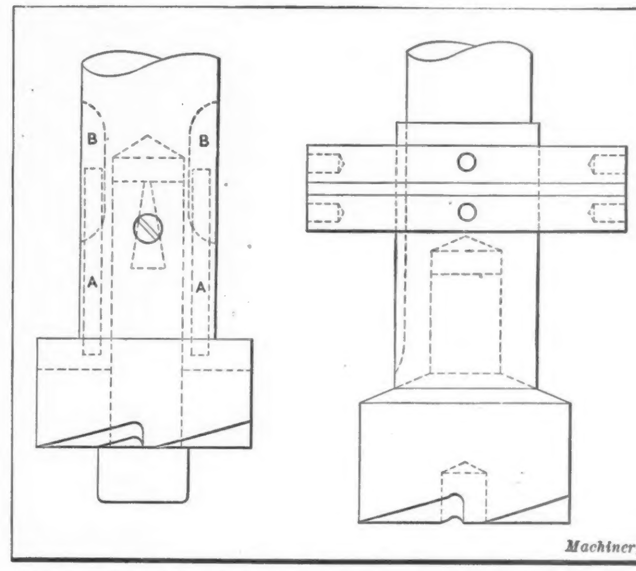


Fig. 6. Form of Spot-facing Tool that is easily repaired

Fig. 7. Tool for spot-facing Surfaces drilled and reamed in a Jig

The simplest form of spot-facing tool is shown in Fig. 4. This consists of a bar of the requisite length having a hole drilled and reamed near the bottom to accommodate the cutter, which is held in place by a set-screw. Owing to the ease with which it is made, this tool is a favorite with those employed on experimental work, who often have occasion to face off several bosses of different sizes. If the tool is of medium size, say with a one-inch shank, it can be made by a machinist in about one hour. The only feature calling for any degree of accuracy is the angle made by the shank and the bar, which should be 90 degrees. This tool is comparatively short-lived, as it has only one cutting edge, but when only a few holes are to be spot-faced it serves the purpose as well as some of the more elaborate and costly forms.

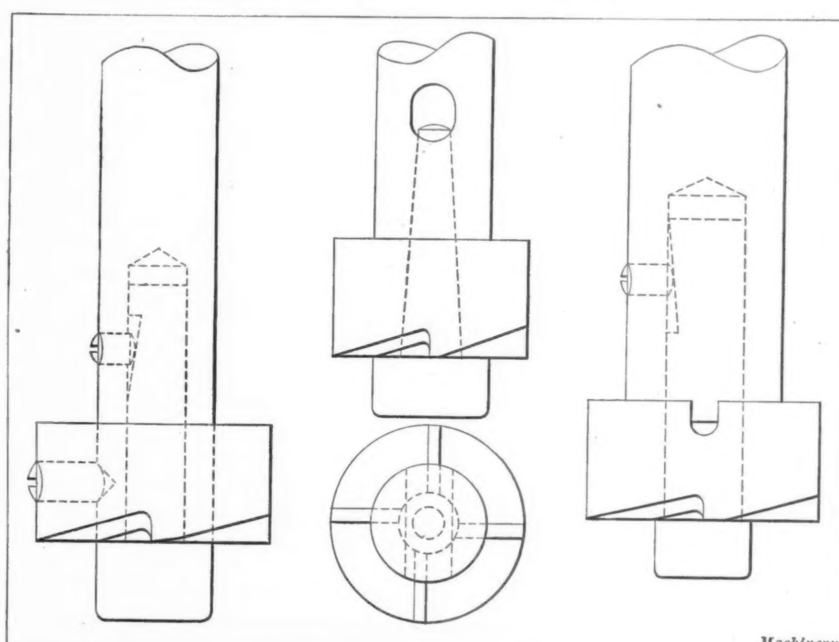


Fig. 1. Spot-facing Tool with Interchangeable Cutter

Fig. 2. Convenient Form of Spot-facing Tool for Small Sizes

Fig. 3. Spot-facing Tool in which Cutter is driven by Projections on Shank

A more substantial form of spot-facing tool is illustrated in Fig. 5. This consists of a shank to which the cutter, which closely resembles a hollow-mill, is fastened by means of a cone-point set-screw. The teeth terminate in a liberal fillet and the angle is comparatively slight. This is essential on rapid production work, where tools are worked to the limit to avoid undue breakage. The pilot can be protected from undue wear by casehardening, if machine steel is used. Boiling in cyanide for fifteen minutes will produce a case deep enough to withstand several weeks of constant use. The cutter should be made of high-speed steel if the material to be machined is cast iron or steel; for brass and aluminum, however ordinary tool steel may be used, especially since the war has forced the price of high-speed steel to an almost prohibitive mark. If an accurate face is desired, the hole in the cutter should be finished after hardening by grinding or lapping, and the teeth should be backed off by locating the piece from the hole. If only a fair degree of accuracy is called for, however, the teeth can be backed off with a file before hardening, and in this case no grinding is necessary until the teeth become dull through use.

Occasionally, it is convenient to have spot-facing tools that are interchangeable, as shown in Fig. 1. Here the shank is drilled and reamed to accommodate the pilot, which is held in place by a set-screw, while the cutter is fastened to the shank by another set-screw. By providing several pilots and cutters, quite a variety of work can be taken care of without making complete tools for each hole. The shank can be left soft, but the cutters and pilots should be finished by grinding after hardening. It is not necessary to make the pilots of tool steel, as ordinary machine steel, casehardened by packing in bone dust, gives equally good results. The tool shown in Fig. 2 has a removable pilot, but inasmuch as the shank and cutter are made integral it is an expensive form of construction. For small sizes, however, say one inch in diameter and smaller, this form is often used. In sharpening, the pilot is removed and the tool is located by the shank.

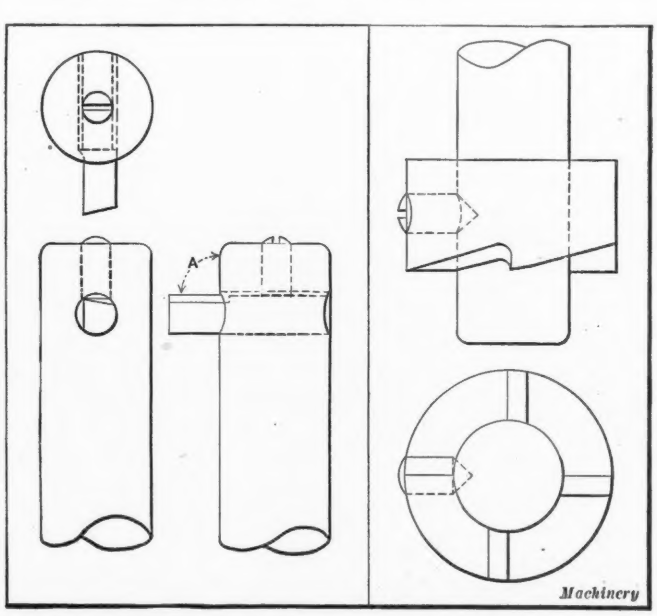


Fig. 4. Simplest Form of Spot-facing Tool

Fig. 5. Rapid-production Spot-facing Tool

[1] Address: 435 Harvard Place, Indianapolis, Ind.

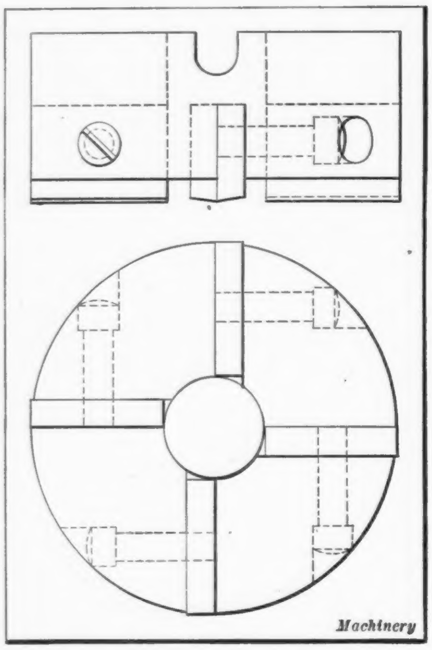


Fig. 8. Spot-facing Tool with Inserted Teeth

A good design is illustrated in Fig. 3. The pilot locates the cutter, being fastened by a set-screw, while the strain of driving is taken by two projections, milled on the end of the shank, which fit a slot in the top of the cutter. This is a practical form of tool if properly made. As the illustration shows, the slot in the top of the cutter terminates in a half-round section; this form is essential, for a sharp corner at this point would be very likely to result in a fracture.

A unique form of spot-facing tool is shown in Fig. 6. The cutter is driven by two pins *A* that are a driving fit in the shank. Slots *B* are milled with a Woodruff key cutter for the purpose of driving out the pins when necessary. When the pins shear off, which sometimes happens, all that is necessary is to remove the pieces that have been cut off and drive the pins down slightly; the cutter is then ready for use. With the form shown in Fig. 3, it would be necessary to remill the end of the shank, which would take at least an hour's time, whereas with the pin design the operator can repair the damage in a few minutes. For this reason the pin form of tool is extensively used.

Comparatively large spot-facing tools, from two inches in diameter upward, are often made with inserted teeth as shown in Fig. 8. The cutter-head can be made of machine steel while the cutters can be of either tool or high-speed steel according to the nature of the work. The cutters are held in place by fillister-head screws. As the cutters seat firmly on the bottoms of the slots provided for them, one screw suffices to hold each cutter in place. The wear on the cutter-head is slight, and it should last indefinitely; when the cutters have been ground until they have become useless, they can be replaced at slight cost.

It is often advisable to spot-face surfaces on work that is drilled and reamed in a jig, in which case it is a good plan to dispense with the pilot, guiding the tool by means of a supplementary bushing inserted in the jacket bushing. As shown in Fig. 7, the cutter is held to the shank by means of a coarse-threaded screw machined to fit rather loosely, as the tool is centered by the bevel. The two collars are threaded to the shank and are for the purpose of adjusting the depth of cut as occasion requires; as they bear on the top of the bushing they should be hardened and ground true. A cutter of this kind could, of course, be guided by a pilot, but as spot-facing tools are generally broken by the pilot galling up it is a good plan to eliminate this feature when possible. In order to save the expense of an extra bushing, these tools are sometimes run directly in the jacket bushing, but this is poor economy, as the bushing is soon worn oversize, and the accuracy of the jig is impaired. The tools described are among the simple things that are often lacking, even in many well organized shops, but a little attention to simple tools often leads to efficient results, thus aiding materially in cutting down the cost of production.

* * *

In order to prevent the misappropriation of foreign trademarks, the president of Costa Rica has ordered that no trademark that is well known in the country, because of the advertising or the sale of the trademarked articles, shall be registered unless authority to apply for such registration is proved.

THE GRINDING WHEEL[1]

The electrochemist speaks of the abrasive wheel and the automobile manufacturer of the emery wheel, but the manufacturer thinks that neither of these words adequately describes his product, and so has adopted the term "grinding wheel." This term is here restricted to those wheels that are composed of two main constituents: the abrasive and the bond, or the substance that holds the particles of abrasive together. The commercial method of classifying grinding wheels is by the kind of bonding material used.

The most important type is the vitrified wheel. The bonding material in this type is composed of various kinds of clay mixed according to definite, secret formulas. Weighed amounts of the abrasive and the bond and a measured amount of water are stirred together in a mixing kettle for a certain length of time and then the mixture is drawn off from the bottom of the kettles into molds and allowed to dry. When dried, the wheels are taken to the shaving department, where they are turned to the approximate dimensions and shape called for by the order.

A kind of vitrified wheel, known as pressed wheel, is made by the pressed process. In this case, only enough water is added to the bonding clays to make the particles stick together to a slight degree. The abrasive and bond are mixed in kneading machines and are then placed in an iron mold and subjected to pressure by powerful hydraulic presses. The pressure applied depends on the grade of hardness desired. These wheels do not need shaving. The next operation is the heat-treatment, in which the wheels are subjected to a heat that will properly vitrify and mature the bond; the highest temperature reached is about the melting point of steel. The length of time required for heating, the length of time during which the wheel is subject to high heat, and the cooling period must be carefully controlled.

In silicate wheels, the bonding material is a commercial grade of silicate of soda, commonly known as water-glass, to which certain chemicals are added to make the bond waterproof. A weighed amount of the grain and a measured amount of the bonding material are placed in long cylinders, which are slowly revolved, end for end, until a uniform mixture is obtained. The mixed mass is placed in an iron mold of the approximate dimensions called for by the order and rammed into place by hand or air hammers. The wheel is then baked.

The name elastic wheel is derived from the fact that the bonding material has quite a degree of elasticity. The bond is of organic nature, the most satisfactory material being shellac, to which certain chemicals are added to facilitate hardening in the baking and also to make the wheel waterproof. Weighed amounts of the grain and the bond are thoroughly mixed and then dumped into large shallow pans and allowed to cool, thus becoming brittle. This brittle cake of abrasive and bond is broken into small pieces and then put through rolls that break the mass into the individual grain. The rolls do not fit close enough, however, to reduce the size of the grain, the idea simply being to produce a mass composed of loose grains, each of which has a coating of shellac. The material is then placed in an iron mold the approximate shape of the wheel, heated and then subjected to pressure. The amount of pressure depends on the degree of hardness desired. The mold and mass are again placed in a steam box and heated until the bond becomes permanently hard.

In vulcanized wheels, the bonding material is rubber, and their manufacture is practically like that of any other hard-rubber product. A weighed amount of the very best grade of crude rubber, the right proportion of sulphur, and a weighed amount of grain are thoroughly mixed by numerous passes in a vertical direction. After a uniform mixture is obtained, the mass is passed through a set of rolls that passes the material in a horizontal direction. It is then rolled down to the required thickness, cut to the required diameter, and a hole of the required diameter is cut in the center. The next operation is vulcanizing, which does not differ from the vulcanizing of any other rubber product.

[1]Abstract of a paper by R. G. Williams read before the American Electrochemical Society, in Detroit, May, 1917.

The next operation in the making of the wheels is that of truing, or bringing the wheels to the dimensions called for on the order. The wheels are mounted in a three-jaw chuck, revolved, and special tools resembling an emery-wheel dresser are brought up against the side of the wheel. In order to bring the wheels to the desired diameter, they are firmly held on a revolving arbor and the dressing tool passed back and forth across the face, gradually reducing the wheel to the desired size. For fine wheels that must be carefully shaped on the face, a diamond is securely mounted in a fixture and slowly passed across the face of the wheel. Light cuts only are taken so as not to crack and destroy the diamond.

The bushing, as it is termed, consists of lead or a babbitt. The wheel is allowed to rest on its side in a three-jaw chuck and is carefully centered; then a steel arbor from 0.002 to 0.005 inch larger than the desired hole in the wheel is placed in the center hole in the chuck and the lead poured around the arbor. When the lead has solidified, the wheel is removed from the chuck and the arbor is carefully driven out with a soft hammer. The bushing is then trimmed, so that it is not quite flush with the sides of the wheel; this is to provide clearance so that when the wheel is mounted on the machine there will be no possibility of stress being concentrated at the hole of the wheel.

In the next operation, the speed test, the wheel is revolved at a speed higher than that recommended for its operation, in order that the manufacturer may know that his product goes out with a sufficient factor of safety. The testing speed for wheels is 9000 surface feet per minute, except for those of organic bonds, when the test speed is higher. Since wheels are recommended to operate at about 5000 surface feet per minute, this gives a factor of safety, based on the squares of these speeds, of between 3 and 4. A careful record of every test is kept; and before these records are filed, the men that keep them are required to appear before a justice of the peace and swear that their statements are true.

Grinding Characteristics of Various Abrasives

Probably the most important physical property of an abrasive is hardness. Other properties, such as toughness and ability to resist shock, are also important, but knowledge of the art of grinding has not advanced sufficiently for us to state definitely the relative importance of the different physical characteristics; that is, we cannot state on which of the properties the grinding action of the abrasive most depends. It is known that the artificial abrasives are harder than corundum but not so hard as diamond. It is hard to determine differences in the hardness of artificial abrasives, although it is known that carbide-of-silicon abrasives are harder than aluminous abrasives.

When a grinding wheel containing a certain abrasive satisfactorily grinds very tough material, it is said to possess considerable toughness. Actual experience has shown that when materials of low tensile strength, such as cast iron, brass, bronze, etc., are ground, carbide of silicon, which is hard but relatively weak, is more efficient than aluminous abrasives. On the other hand, when grinding materials of high tensile strength, ranging all the way from medium carbon to the high-speed steels, aluminous abrasives give better satisfaction.

Precision Grinding Machines

The word "precision" is used to designate a type of grinding machine, because these machines must be capable of producing work of great accuracy. The art of precision grinding has advanced rapidly during the past few years and the demand of the automobile manufacturer should receive credit for producing most of the advance. Only a few years ago anyone advocating the accurate grinding of shafts five or six inches long without table or wheel traverse would have been condemned as too visionary; this step in the art has long since been passed. It is now possible to grind more than one diameter at one time with one wheel; this is an outgrowth of the use of very wide wheels taking extreme cuts without any traverse of the table or the wheel.

A machine using a very wide wheel, say ten or twelve inches, must be very rigid as well as capable of producing refined work. Imagine the forces present when a wheel weighing 150 or 200 pounds revolves on a spindle, in plain bearings, at 1000 to 1200 revolutions per minute. This spindle must be kept in perfect alignment so that the face of the grinding wheel will produce an absolutely straight cylinder, and there must be ample weight in the base of the machine and in the wheel-slide to absorb all vibration caused by the revolving mass. Another factor that must be borne in mind is the resistance offered when the wheel is brought in contact with the work, as small particles of a very hard material are removed at an extremely rapid rate. The spindle bearings must be so adjusted that the boxes will be quite hot when the machine is in operation; in fact, a temperature of about 140 degrees F. is desirable.

Limits of 0.0005 inch on the work being ground are very common; those of 0.00025 inch are quite common; and in some cases less than 0.00025 inch is demanded. When the work is reduced 0.00025 inch, the massive slide carrying the wheel-spindle and the grinding wheel moves forward only one-half this distance, or 0.000125 inch. If it were possible to split a piece of tissue paper into twelve thicknesses, the thickness of one piece would represent the motion of the wheel-slide when the grinding wheel removes 0.00025 inch from the work, and this accuracy must be maintained not only where very small cuts are taken, but also when the object is to grind off as many cubic inches per minute as possible.

* * *

CONFERENCE WITH GOV. WHITMAN

A conference between Governor Whitman of New York State and trade press editors and publishers was held in Albany, July 25, at the Executive Mansion. The conference is likely to have bearing on some of the relations of the state executive to the various industries represented. Questions of transportation, food control, marketing, conservation of coal and lumber, relations of manufacturers and labor, the importance of exempting machinists and toolmakers and others vitally necessary to the prosecution of this war with machinery, were discussed at some length. A committee of five editors has been appointed to give Governor Whitman the expert advice they are able to furnish because of personal knowledge and connections that enable them to draw from sources of information which may be of service in the prosecution of war.

* * *

The new color scheme of signal indications, by which white lights will be eliminated altogether, was placed in effect on all lines of the Pennsylvania Railroad east of Pittsburg, June 28. Nearly a year of preparatory work was required to make the change possible. Great difficulty was experienced in obtaining deliveries of materials, owing to the war conditions. The decision to eliminate white from the signal color scheme was reached on account of the increasing use of white lights in buildings, driveways, roads and streets close or adjacent to the railroad's right-of-way. Under the new plan, green will replace white for "clear" or "proceed." "Caution" will be indicated by yellow. Red will mean "stop," as heretofore. The glasses in all the semaphore signals and the following devices have been altered to conform to the new plan of color indication: marker lights on the rear of passenger and freight trains; switch lamps and targets; markers for track tanks; "slow" signs; "resume speed" signs; and hand lamps at interlocking and block signal stations.

* * *

An elaborate electrical sign has recently been erected by the Rice Leaders of the World Association in a prominent position overlooking upper Broadway in New York City. The firms in the machinery and tool field whose products are advertised by flashes on this sign are the Billings & Spencer Co., Hartford, Conn.; the Nicholson File Co., Providence, R. I.; and the L. S. Starrett Co., Athol, Mass. The names and products of the various firms that are members of the Rice Leaders of the World Association are flashed upon the sign in rapid succession. The upper part of the sign is composed of the elaborate coat-of-arms or emblem of the Association in colors.

LESSONS FROM BRITISH EXPERIENCE

In 1915, the British Minister of Munitions appointed a committee to consider and advise on questions of industrial fatigue, hours of labor, and other matters affecting the personal health and physical efficiency of workers in munition factories and workshops. This committee, after making a careful investigation, has made the following suggestions and recommendations with the purpose of securing maximum output over a period of months, or even years, and at the same time safeguarding the physical efficiency of the workers:

If the maximum output is to be secured and maintained for any length of time, a weekly rest period must be allowed. Except for short periods, continuous work is a mistake and does not increase the output. On economic and social grounds, this weekly rest period is best provided on Sunday. The foremen and the higher management even more certainly require definite periods of rest. They have never spared themselves; they carry a heavy burden of responsibility and cannot be replaced. It is of primary importance, in the interests of the nation, that they should be allowed that rest which is essential to the maintenance of their health.

The objections to overtime, briefly stated, are: It is likely to impose too severe a strain upon the workers, which adversely affects the rate of production and quality of output during the whole period of work as well as during the hours of overtime. It frequently results in a large amount of lost time, which is attributed to the workers becoming exhausted and taking a rest, and also to sickness. It imposes a serious strain upon the management, the executive staff, and foremen, since these persons cannot take days off like the ordinary worker. It is likely to curtail unduly the period of rest and sleep available for those who have to travel long distances to and from work, a matter of special importance in the case of young persons. The fatigue entailed increases the temptation to indulge in the consumption of alcohol.

Admitting that overtime must continue, for adult male workers the average weekly hours (exclusive of meals) should not exceed 65 to 67, including overtime. It may be desirable to differentiate to some extent between different kinds of work and to fix a rather low limit of hours for work requiring close individual attention. Where practicable, the overtime should be concentrated within three or four days in the week, which should preferably not be consecutive. Where overtime is necessary, it is specially important that there should be no Sunday work. The committee feels that the need for overtime among women and girls is much less pressing than it is for men, and should be abandoned in favor of shifts.

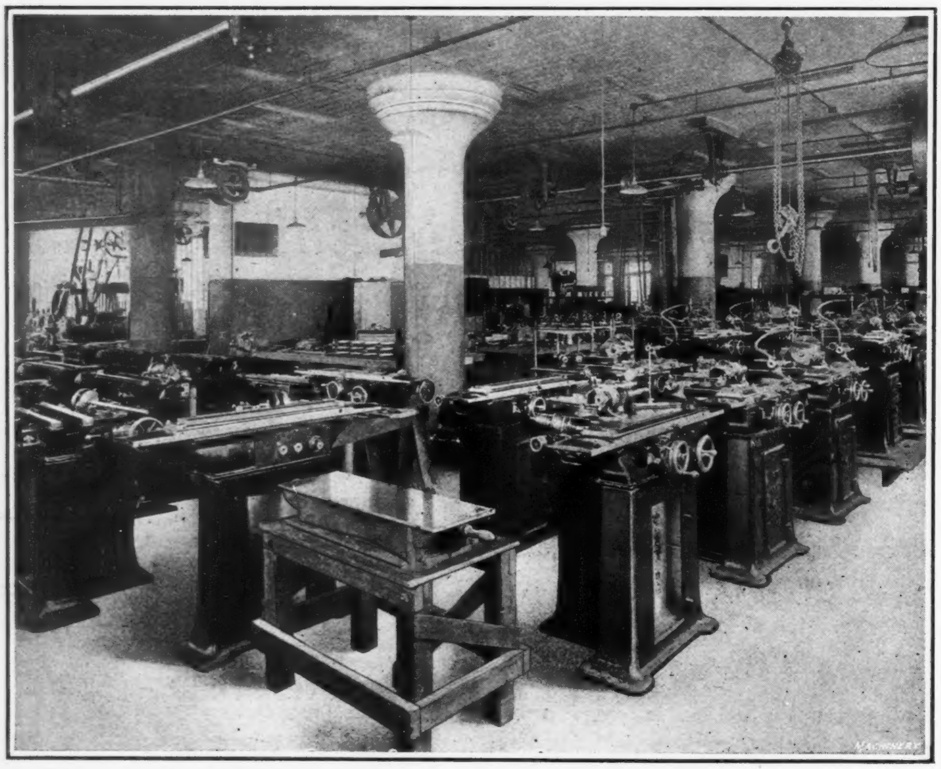
Although work on shifts involves night work, night work is not a good thing in itself because it is uneconomical. Though wages are paid at a higher rate, the rate of output, more particularly during the last two or three hours of a twelve-hour shift, is generally lower. Supervision is frequently unsatisfactory. Conditions of lighting are seldom as good as in the daytime and make fine work more difficult. Workers experience great difficulty in sleeping by day. The unfamiliar meal hour makes it difficult for the workers to consume substantial food, and digestion is likely to be upset.

As a method of speeding up production, the committee recommends the careful regulation of rest periods. It has been found that the operatives, if left to themselves, take rests at irregular and often unsuitable times; hence it is much better for the rest periods to be chosen for them. For instance, a ten-minute period in the middle of the morning and the afternoon, during which the operatives remain at their machines, but have tea or other nutriment brought them by boys or by traveling canteens, has been found a valuable aid to output. Some kinds of work need longer and more frequent rest periods than others; this is determined only by experience.

The committee found that the munition workers, in general, have been allowed to reach a state of reduced efficiency and lowered health, which might have been avoided without reduction of output by attention to the details of daily and weekly rests. The signs of fatigue are even more noticeable in the case of managers and foremen.

The committee calls attention to the fact that bad lighting affects output unfavorably by making good and rapid work difficult, and also by causing headaches and other effects of eyestrain. The difficulties of supervision are further increased. The essentials of good lighting are: adequacy; a reasonable degree of constancy and uniformity of illumination over the necessary area of work; the placing or shading of lamps so that light does not fall directly on the eye of the operator when engaged at his work or when looking horizontally across the work-room; the placing of lights so as to avoid the casting of extraneous shadows on the work. The committee also calls attention to the need of special measures to prevent undue strain upon the eyesight or to reduce the liability to accidents to a minimum. It suggests that the eyesight of operatives employed on close work be tested and the persons supplied with glasses when necessary; it also suggests guarding the eyes by the use of goggles.

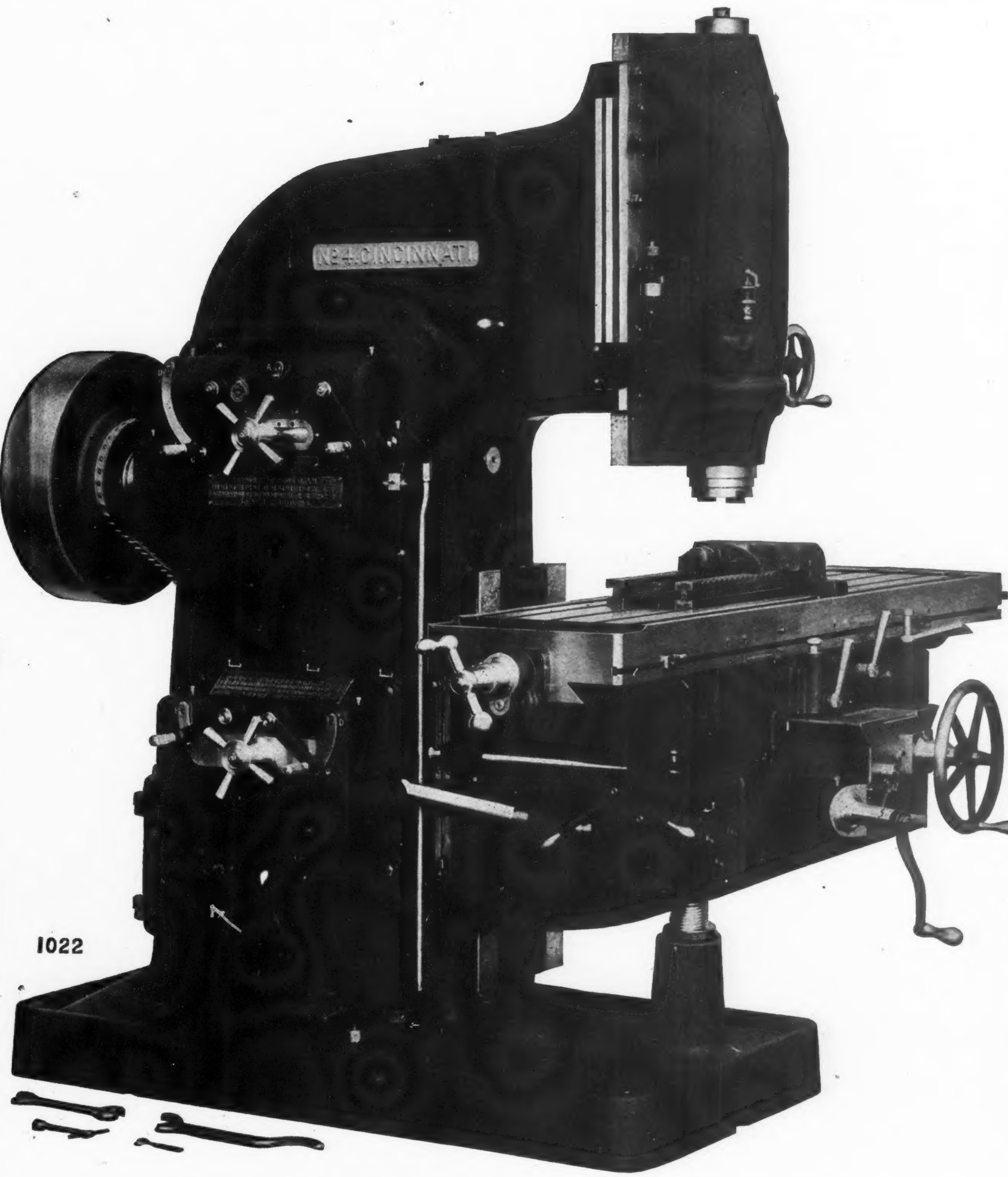
* * *



Assembling, erecting and testing Ott No. 1 Universal Grinding Machines

The illustration shows the floor of the Ott Grinder Co. in the Industrial Building, Indianapolis, Ind. The view is of interest, as it gives an idea of the rapid development of one comparatively small manufacturer who started a few months ago to build the line of cylindrical grinding machines acquired by purchase from the Modern Tool Co. of Erie, Pa. The growth of the business reflects the fact that the cylindrical grinding machine is no longer regarded as a refinement for the use of toolmakers only, but is rapidly becoming an indispensable machine tool to many concerns that found no use for it in their machine shops a few years ago. The view shows thirty No. 1 universal grinding machines in the various stages of assembling, erecting and final testing under belt. These are part of fifty machines put through in one lot. The first machine in the front row is being tested for accuracy, a Brown & Sharpe indicator being used for testing the alignment of both wheel-spindle and headstock.

Cincinnati Verticals



Unusual Spindle Power.
Heat Treated Alloy Steel Hardened Gearing.
Massive Spindle Head Construction.
Handy—Can mill around a rectangle without stopping feed or speed.

These are some reasons why you should use Cincinnati Verticals

THE CINCINNATI MILLING MACHINE CO.
CINCINNATI, OHIO, U. S. A.

PERSONALS

B. H. Blood has been appointed general manager of the Pratt & Whitney Co., Hartford, Conn., following the resignation of B. M. W. Hanson.

L. A. Larsen was appointed comptroller, effective July 1, at a recent meeting of the board of directors of the American Locomotive Co., New York City.

B. Orum Andresen has joined the engineering staff of Aall & Co., of Tokyo, Japan, the Japanese agents for the American Steel Export Co., Woolworth Bldg., New York City.

Charles H. Purdy, superintendent of the Dalton Machine Co., of New York City, has resigned to engage in the designing and building of special machinery, with offices at 103 E. 125th St., New York City.

H. L. Paulus, R. G. Ferguson, and F. L. Graf, for many years connected with the Baird Machinery Co., of Pittsburg, Pa., have resigned and joined forces with the J. S. Miller Machinery Co., of Pittsburg.

B. M. W. Hanson, general manager of the Pratt & Whitney Co., Hartford, Conn., has resigned, and has been made vice-president and general manager of Colt's Patent Fire Arms Mfg. Co. of Hartford.

Albert P. Weigel, superintendent and general manager of the Superior Machine Tool Co., Kokomo, Ind., has resigned and organized the Weigel Machine Tool Co., Peru, Ind., to manufacture machine tools.

Edgar N. Dollin, organizer and president of the Acme Die-Casting Corporation, Brooklyn, N. Y., has sold his holdings in the company and retired from active management. Mr. Dollin was formerly secretary of the Doehler Die-Casting Co., and president of the Kalak Water Co. He has had a wide business experience as a lawyer and as a manufacturer. His new activities have not been announced.

R. M. Klein has been appointed sales manager of the International Oxygen Co., with headquarters at the company's main office at 115 Broadway, New York City. Mr. Klein brings to his new position technical training, and experience as an engineer in the United States government employ, as salesman and sales manager of the Diehl Mfg. Co., and as manufacturers' representative handling a number of mechanical lines.

R. J. Doty, who for the last three and one-half years has been in charge of the steel foundry of the Isaac Johnson Co., Spuyten Duyvil, N. Y., has resigned his position to become associated with the Sivyer Steel Casting Co., Milwaukee, Wis. The company is enlarging its plant and installing an additional three-ton electric furnace to take care of its growing business among the motor truck, tractor, and general machinery manufacturers.

George A. Willard, for many years a manufacturer of lathes in Cincinnati, Ohio, has sold the Willard Machine & Tool Co. to G. Mattman and Thomas L. Bratten. Mr. Mattman was formerly European representative of the Cincinnati Milling Machine Co., and Mr. Bratten held an executive position with the Employers' Liability Corporation, and is well known in the trade. Mr. Willard will retire from business and take a much needed rest at his summer home in Michigan.

F. H. Tackaberry, general agent of the American Steel Export Co., Woolworth Bldg., New York City, sailed July 7 for South America. Mr. Tackaberry will visit the principal South American cities—Rio de Janeiro, Sao Paulo, Buenos Aires, Montevideo, La Plata, Rosario, Valparaiso, Santiago, etc., his object being primarily to collaborate with the company's factory agents and acquaint them with the market conditions in the United States for iron and steel and engineering and contracting.

OBITUARIES

H. C. Mather, president of the Moore Oil Co., Cincinnati, Ohio, was drowned June 26 in Lake Superior near Calumet, Mich.

Casimir von Philp died July 5 at Ocean City, N. J., aged sixty-four years. He was born in Sweden, but came to the United States nearly forty years ago. Since 1890, he was connected with the Bethlehem Steel Co., at Bethlehem, Pa., for a considerable period as chief engineer and recently as manager of the machinery department. As an engineer, his career was marked by unusual ability and originality. His inventions included improvements in rolling mills and special features of heavy forging equipment produced at the Bethlehem works. He was a member of the American Society of Mechanical Engineers, the American Society of Swedish Engineers, and the Engineers' Club of New York. He was also recently appointed a member of the John Ericsson Memorial Commission.

COMING EVENTS

August 30—Monthly meeting of the Rochester Society of Technical Draftsmen, in Rooms 131-137, Sibley Block, 328 Main St., E., Rochester, N. Y. O. L. Angevine, Jr., secretary, 857 Genesee St., Rochester.

August 30-September 1—Ninth annual convention of the American Railway Tool Foreman's Association, Chicago, Ill.; Sherman Hotel, headquarters. C. N. Thulin, secretary-treasurer, 935 Peoples Gas Bldg., Chicago, Ill.

September 10-15—Annual convention of the National Safety Council, New York City; Hotel Astor, headquarters. Marcus A. Dow, president, Grand Central Station, New York City.

September 10-15—Exposition of safety appliances at the Grand Central Palace, New York City, under the auspices of the American Museum of Safety, 18 W. 24th St., New York City. Arthur H. Young, director.

September 25-28—Twenty-second meeting of the American Foundrymen's Association, Boston, Mass.; Copley-Plaza Hotel, headquarters. The registration booth will be in the Mechanics' Bldg., where the exhibition of foundry and machine shop equipment and supplies will be held. A. O. Backert, secretary-treasurer, 12th and Chestnut Sts., Cleveland, Ohio.

September 27-29—Informal congress and reunion of American and Canadian engineers and architects of Norwegian birth or descent in Chicago at Chicago Norske Klub, 2346 N. Kedzie Blvd., Logan Square, Chicago, Ill.

SOCIETIES, SCHOOLS AND COLLEGES

Brown University, Providence, R. I. Circular on the new course in engineering containing illustrations of the laboratory equipment and statement of the requirements for the degree of bachelor of science in engineering.

Polytechnic Institute of Brooklyn, Brooklyn, N. Y. Pamphlet outlining the evening courses offered by the institute in engineering, chemistry, physics, mathematics, drawing, history, economics and languages. The season 1917-1918 begins October 1 and continues until the courses are completed.

Y. M. C. A. Industrial Department, 124 E. 28th St., New York City. Pamphlet outlining the organized industrial extension work undertaken by the City Association Among Industrial Workers for the benefit of workers in factories and shops throughout the country. The work comprises educational, social, physical, religious and general activities.

Electric Power Club at its annual meeting held in Washington, D. C., June 11-12, elected C. L. Collens, of the Reliance Electric & Engineering Co., president; F. S. Hunting, of the Fort Wayne Works of the General Electric Co., vice-president; and C. H. Roth, of Roth Bros. & Co., secretary-treasurer. A resolution tendering to the government the use of the manufacturing plants of the members and offering the services of the committees was passed.

NEW BOOKS AND PAMPHLETS

Constitution of the United Nations of the Earth. By Edgar D. Brinkerhoff. 22 pages, 6 by 9 inches. Published by the Pamphlet Publishing Co., Fall River, Mass.

This remarkable document is virtually a paraphrase of the Constitution of the United States adapted for the united nations of the earth as visioned by the author.

Oxy-acetylene Welding Practice. By Robert J. Kehl. 105 pages, 5½ by 8¼ inches; 111 illustrations. Published by the American Technical Society, Chicago, Ill. Price, $1.

The work is a practical presentation of the processes of welding, cutting and lead burning, with special attention to welding practice for steel, cast iron, aluminum, copper and brass. It is illustrated with many examples showing how to handle the torch and to prepare work for welding. Examples of automobile repair are included, thus making the work of special interest to owners of garages and others concerned with motor car repairs.

How to Make High-pressure Transformers. By F. E. Austin. 46 pages, 4½ by 7¼ inches; 21 illustrations. Second edition. Published by Prof. F. E. Austin, Box 441, Hanover, N. H. Price, 65 cents.

The first edition of this book was published in 1914. It is essentially a work on experimental electrical engineering written with regard to the well-known fact that to learn things we must do things. The student is instructed in the theory of high-pressure transformer design by designing and making a transformer. The work is both practical and technical, but not too highly technical to place it beyond the comprehension of men having a good high school education. It contains data that should be of use to engineers who wish to brush up on the principles of electrical engineering.

Machine Drawing. By Ralph W. Hills. 22 pages, 6 by 9 inches; 119 illustrations. Published by the McGraw-Hill Book Co., New York City. Price, $1.

Many books have been published on mechanical drawing; these may be divided into two general classes: first, those that teach drawing for drawing's sake, and, second, those that teach mechanical drawing for the purpose of making the student a practical draftsman or to give him the knowledge that will enable him to make use of mechanical drawing to the best advantage. This work is an excellent example of the second class. The material is the first half of the instruction papers in machine drawing, as developed and used by the Extension Division of the University of Wisconsin. The subject matter deals with instruments and materials, principles of mechanical drawing, screws and screw fastenings, sections, technical sketching, tracing, assembly and detail drawings. Some useful data are included which afford good examples for practice in making up tables. The work is one that we recommend to students whether in school or engaged in home study.

Locomotive Valves and Valve Gears. By Jacob H. Yoder and George B. Wharen. 272 pages, 6 by 9 inches; 274 illustrations. Published by D. Van Nostrand Co., New York City. Price, $3 net.

This work is, we believe, the first special treatise on valves, valve gears and valve setting published which may be recommended to railway mechanics as a practical guide for locomotive valve setting and a treatise on the common and uncommon types of valve gears. It explains the construction and action of the plain slide valve, the piston valve, and the valve gears used to operate them, as applied to locomotives, and is based on notes used in schools for apprentices on the Pennsylvania Railroad. The authors state in the preface that the book had been prepared to meet the general desire among railroad shop men to acquaint themselves with the valves and valve gears applied to modern locomotives, and to master the principles of valve motion as a preparation to valve setting. Valve motion and valve setting have always appeared to many shop men as more or less of a mystery, and it is the aim of the work to enable those interested to acquire first-hand knowledge. The subject matter is given in seven chapters, the contents of which are as follows: Locomotive Valves and Valve Gears; Stephenson Valve Gear; Walschaerts Valve Gear; Baker Locomotive Valve Gear—Southern Locomotive Valve Gear—Joy Valve Gear—Young Locomotive Valve, Valve Gear, and Reverse Gear—Gooch Stationary Link—Allen Valve Gear—Effects of Altering the Valve and Its Events; Locomotive Valve Setting; Steam Engine

Indicator and the Indicator Diagram. The illustrations and directions for valve setting leave little to the imagination, the steps pursued by the practical valve setter in securing the data required for adjustment of the eccentrics and eccentric rods being clearly and specifically described. The book is one that we heartily recommend to all railway students and others interested in locomotive valve motion.

NEW CATALOGUES AND CIRCULARS

Warner Hammer Co., Cromwell, Conn. Price list of Warner hammers and edge tools.

Metalwood Mfg. Co., Detroit, Mich. Bulletin B-44 of the Metalwood inverted type adjustable forming press, No. 121.

Metalwood Mfg Co., Detroit, Mich. Circular B-53 of the Metalwood No. 79 hydro-mechanical banding press for banding shells from 3 to 5 inches.

Standard Alloys Co., Pittsburg, Pa. Pamphlet entitled "Uranium in Steel," presenting comparative tests of uranium and other high-speed steels.

Day & Zimmermann, Inc., Philadelphia, Pa., has issued a bulletin showing typical industrial plants throughout the country constructed by this company.

Link-Belt Co., Chicago, Ill. Book 258 entitled "The Ideal Drive for Textile Machinery," illustrating Link-Belt silent chain installations in textile mills.

Cummings Ship Instrument Works, Boston, Mass. Bulletin descriptive of the Gary-Cummings torsion meter for determining the horsepower transmitted by shafts.

Hisey-Wolf Machine Co., Cincinnati, Ohio. Bulletin 1403, describing "Hisey" portable electric surface grinders, made for use with either direct or alternating current.

Oakley Chemical Co., 26 Thames St., New York City. Information sheet 857 on munitions manufacture, illustrating uses of "Oakite" cleaning and cutting compounds.

Stanley Belting Corporation, 32-40 S. Clinton St., Chicago, Ill. Circular of Stanley woven cotton belting, made in single, double and triple thicknesses and in all widths up to forty-two inches.

Peter A. Frasse & Co., Inc., 417 Canal St., New York City. July stock list giving sizes in stock ready for immediate shipment of Frasse electric tool steel, drill rods, steel shafting and strip steel.

Messer Mfg. Co., 117-121 N. 7th St., Philadelphia, Pa. Catalogue of Messer portable oxy-acetylene apparatus for welding and cutting; regulating valves, welding blow-pipes and acetylene generators.

Nagle Corliss Engine Works, Erie, Pa. Bulletin 27, illustrating and describing Nagle-Corliss Class A-E and B-E steam- and power-driven air compressors with capacities from 3 to 8000 cubic feet of free air per minute.

Sunderland Machinery & Supply Co., 1006-1010 Douglas St., Omaha, Neb. Circular of the Fox arbor press No. 4, having capacity for work 19 inches diameter. The movement of the ram is 17½ inches and the leverage 60 to 1.

Sprague Electric Works of General Electric Co., 527-531 W. 34th St., New York City. Bulletin 48923 of Type W, one- to six-ton electric hoists, giving specifications, dimensions, and weights, and showing a few uses of standard Type W hoists.

Whitman & Barnes Mfg. Co., Akron, Ohio. Catalogue 90, 158 pages, 4¾ by 7¼ inches, containing tables of dimensions and prices for twist drills, reamers, drop-forgings, drop-forged and screw wrenches, spring cotters, and flat spring and riveted keys.

General Electric Co., Schenectady, N. Y. Bulletin 42014 entitled "Headlights and Turbo-generators for Steam Locomotives," describing a turbo-generator set, designed to meet the rigid requirements of locomotive headlight service, and giving diagrams showing the assembly.

Detroit Twist Drill Co., Detroit, Mich. Catalogue 18, 251 pages, 5 by 7½ inches, containing tables of dimensions and prices for twist drills, reamers, counterbores, milling cutters, end-mills, etc. Special sections are given for millimeter sizes of twist drills and reamers.

Buffalo Forge Co., Buffalo, N. Y. Catalogue 256 of Buffalo exhaust fans for the removal of shavings, sawdust, smoke, fumes, etc., containing also engineering data and extracts from state laws regarding the provision of exhaust fans in manufacturing plants as required by law.

Manufacturers Equipment Co., 169-179 N. Jefferson St., Chicago, Ill. Circular illustrating "M. C. E." three-jaw air-operated chucks, which are furnished in two styles—semi-universal and full universal. The chucks are made in five sizes, ranging from 8 to 18 inches diameter, inclusive.

Manufacturers Equipment Co., 169-179 N. Jefferson St., Chicago, Ill. Catalogue of labor-saving devices, including two-jaw air chucks, hinge collet chucks, milling machine chucks, air cylinders, air valves, air vises, bath cock millers, self-opening die-heads, forming tools and collapsible taps.

Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill. Bulletin 34-Y treating of gas- and gasoline-driven air compressors. The "Simplate" flat disk air inlet and discharge valves with which these compressors are equipped enable high compressor speeds and efficiencies to be obtained.

Oakley Chemical Co., 26 Thames St., New York City. Information Sheet 860 on "Oakite" for cleaning metal parts preparatory to plating. Photomicrographs of oil emulsified by "Oakite" and oil saponified by caustic, are reproduced to show their fundamental difference of action in cleaning metal surfaces.

Hammel Oil Burning Equipment Co., Inc., 409 Pine St., Providence, R. I. Catalogue of the Hammel oil burning apparatus, showing applications to steam and water-tube boilers of horizontal and vertical types; oil pump sets; oil burner governors; and oil firing valves. A list of users of the Hammel burners and furnaces is included.

R. D. Nuttall Co., Pittsburg, Pa. Circular of the Nuttall one-piece expansion joint for pipe lines, which is offered as a leak-proof device requiring no packing and eliminating loops and U-bends from pipe lines. The Nuttall expansion joint is of the accordion type, the corrugations being machined from a solid blank, and not molded or bent to shape.

Bilton Machine Tool Co., Bridgeport, Conn. Bulletins 203 to 221, illustrating and describing automatic gear milling machines, automatic manufacturing milling machines, drill presses built in single-spindle and gang types, automatic cam-feed drill presses, horizontal milling machines, rotary blow riveting machines, automatic worm milling machines, and universal gear hobbing machines.

Chesnutt Mfg. Co., 1301-1303 Independence Ave., Kansas City, Mo. Booklet descriptive of the "Eleveyor," an elevating truck equipped with service swivel casters, which is so designed as to enable it to meet a wide range of work under difficult conditions. The "Eleveyor" elevates the load and then conveys it wherever desired. The book contains reproductions of letters of recommendation from various users of the "Eleveyor."

Stroh Steel-Hardening Process Co., Pittsburg, Pa. Catalogue descriptive of the Stroh Process, which is a method for casting the finest alloy steel together with ordinary soft steel in one solid piece. The resultant casting has a wear-proof alloy steel stratum on the wearing surfaces, while the body is composed of any desired steel and is in no way affected. Illustrations of gears, car wheels, and many large castings made by this process are shown.

Henry Disston & Sons, Inc., Philadelphia, Pa., has inaugurated a monthly house organ for its employes, the first issue of which was published in July. The title of the publication is "Disston Bits," which has a double significance, "bits" being another name for the teeth of inserted-tooth saws, one of the company's products. The announced purpose of the publication is the stimulation and crystallization of good-will and fellowship among the employes, and it is the editorial policy that all illustrations, cartoons, and editorial matter be the work of the employes themselves. The new publication, "Disston Bits" will not in any way conflict with the "Disston Crucible," the trade organ of the company, which has been issued for several years, as the objects and purposes of the two publications are dissimilar.

TRADE NOTES

Cooper Hewitt Electric Co., manufacturer of mercury vapor lamps, has moved its Philadelphia office from 124 S. 8th St. to the Drexel Bldg.

E. R. Senn & Co., manufacturers of "Belt-ol," a scientific oil for treating leather belts, have removed their offices to more spacious quarters at 52 Vanderbilt Ave., New York City.

J. N. Lapointe Machine Co. of Massachusetts, Hudson, Mass., has been organized for machine building, and a one-story cement factory building 80 by 300 feet is being erected. Ralph Lapointe is general manager.

Crosman Stamping Co., Ypsilanti, Mich., is a concern recently incorporated to do general stamping and die work. George J. Crosman is president and treasurer; A. E. Sanford, vice-president; and Lewis H. McLouth, secretary.

Bickett Machine & Mfg. Co., Cincinnati, Ohio, manufacturer of horizontal and vertical milling machines, has added a large office and engineering department to its plant, which occupies the entire second floor of the main building. The lower floor is now required for manufacturing alone.

Phoenix Mfg. Co., Eau Claire, Wis., has moved its Cleveland office from 1430 W. Sixth St. to 913-15 Engineers Bldg., in order to obtain larger quarters, which are required to care for the increase of business. W. L. Harrison is the eastern representative in charge.

Chesapeake Iron Works, P. O. Box 1123, Baltimore, Md., and Westport, Md., are building overhead electric traveling cranes of three-motor direct-current type, having from 5 to 25 tons capacity. The company also builds five-motor double-trolley cranes of any span, having capacity up to 50 tons.

Carlton Machine Tool Co., Cincinnati, Ohio, has moved to 2994 Spring Grove Ave., where a new factory having about three times the floor space of the old shop has been erected. The new shop is equipped with machinery and appliances that will facilitate the production of the line of radial drilling machines made by this company.

Columbia Machine Tool Co., Hamilton, Ohio, which recently acquired the business of the Ceramic Machinery Co., will manufacture machine tools, making a specialty of shaping machines. A plant, 66 by 190 feet, of brick and steel, is being erected, and will be in operation at an early date. E. S. Rich, formerly with the Hamilton Machine Tool Co., is secretary.

Joseph F. Wangler Boiler & Sheet Iron Works Co., St. Louis, Mo., has moved its general offices from 1547 N. 9th St., to 911-912 Federal Reserve Bank Bldg., 415 Pine St. The company was established in St. Louis more than fifty years ago to manufacture steam boilers, tanks, and all kinds of boiler plate and sheet iron work. Joseph A. Wangler, who has been with the company for more than twenty-five years, is president.

La Salle Machine & Tool Co., La Salle, Ill., has taken out a life insurance policy for each of its employes in the group plan, the amounts of which are equal to the yearly wages, limited to a minimum of $300 and a maximum of $2000. It is straight life insurance, and the entire cost is paid by the company. Employes participate in the benefits of the plan when they have been in the employ of the company for six months.

Scott-Spencer Automatic Tool Co., Madison Road and N. & W. R. R., Cincinnati, Ohio, was lately organized to manufacture tools and equipment for automatic screw machines, specializing on this work exclusively. Thomas J. Scott, president, and L. B. Spencer, secretary and treasurer, are practical screw machine operators and are thus equipped by experience to design, make, and test equipment for automatic screw machines to suit various needs.

Davis-Bournonville Co., Jersey City, N. J., opened a welding institute August 1, for the purpose of giving competent instruction in the oxy-acetylene art. The institute will be in charge of Henry Cave, technical director. The class will be held at the Jersey City factory of the company, and a charge will be made to cover the cost of oxygen, acetylene, metals and other supplies consumed. Employers using the oxy-acetylene apparatus can arrange to give a limited number of employes this course in welding and cutting.

Electrical Industrial Co., Drammen, Norway, has consolidated with two other concerns in Norway—the Holm-Hansen Electrical Co., Sandefjord, and the Fridtjov Andersens Telepointage, Christiana. The association will continue to manufacture all articles in the electrical line, and will hereafter conduct its business under the name of the National Industrial Co., with main office at Sandefjord, and branch offices at Drammen and Christiania. The association is represented in New York City by Hans Karlsrud, manager of the Drammen branch, 309 Broadway.

J. T. Slocomb Co., Providence, R. I., manufacturer of machinists' tools, is building an addition of two stories to the main building 60 by 100 feet, making the building four stories in height. Another addition in the rear of the main building was erected last winter and has been in use for the past three months. The main office, stock-room and shipping rooms, will be located on the fourth floor and automatic elevator service will be provided. The additions made in the past year and a half provide facilities that more than double the production.

General Electric Co., Schenectady, N. Y., has erected a building at the Schenectady plant affording approximately 20,000 square feet floor space, which will be devoted exclusively to the manufacture of industrial heating devices. Continuous operation and the most productive grouping of machines have been obtained by the use of individual motor drive, direct-current motors being employed which range up to twenty-five horsepower. Many of the machines were developed especially to meet the unique requirements for machining, assembling and testing heating devices.

Acme Die-Casting Corporation, 5 Bush Terminal Bldg., Brooklyn, N. Y., has issued a statement to the effect that the suit recently brought against it by the Doehler Die-Casting Co. for infringement of patent No. 1,156,093 is limited strictly to the use of certain alloys of aluminum die-cast by a certain process. It does not cover aluminum zinc, aluminum manganese, or aluminum alloys containing 8 per cent or less of copper or more than 20 per cent of copper. The suit does not in any way affect the product and present business of the corporation, as it covers a process not now in use.

Cincinnati Grinder Co., Cincinnati, Ohio, manufacturer of plain, cylindrical, universal, and internal grinding machines, is building a modern plant on Colerain Ave., in the heart of the West End manufacturing district. The new plant will afford 35,000 square feet of floor space and will be modern in its equipment and appointments. The building is of brick and steel construction with saw-tooth roof, and will have a two-story front. The offices will be on the second floor, which is 40 by 96 feet. The rapid growth of the concern has made larger and better facilities for manufacturing imperative. Provision has been made for further extending the plant as the need for more room is felt.

Willard Machine & Tool Co., Cincinnati, Ohio, manufacturer of the Willard 13-inch tool-room lathe, has been sold to G. Mattman and Thomas L. Bratten. The firm name has been changed to Willard Machine Tool Co. Mr. Mattman is well known in the machine tool trade, having been for several years the European representative of the Cincinnati Milling Machine Co. He came to the United States from France in 1904 and worked in the shop for four years, learning the American way of building machinery. He has had wide experience both in the production and selling end. Mr. Bratten, although never identified with the machine tool industry, is also well known to the trade in and about Cincinnati, having held an executive position with the Employers' Liability Corporation, Ltd. For the present, the company will continue to manufacture the Willard 13-inch lathe, which will be somewhat improved, but the intention is to add other machine tools to the line in the near future.

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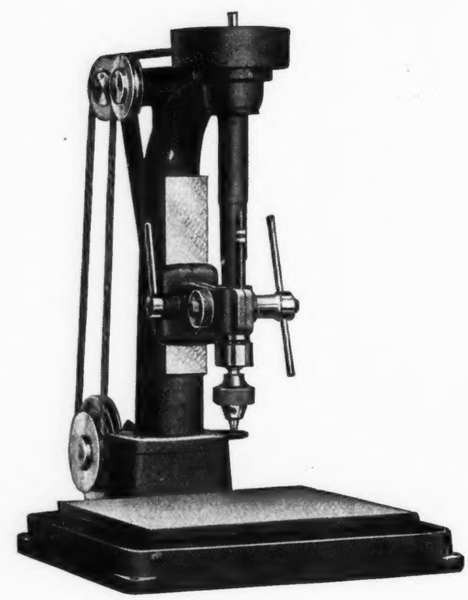
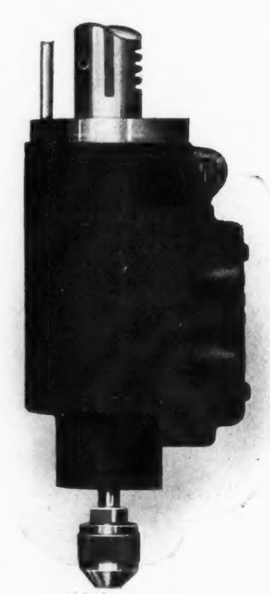
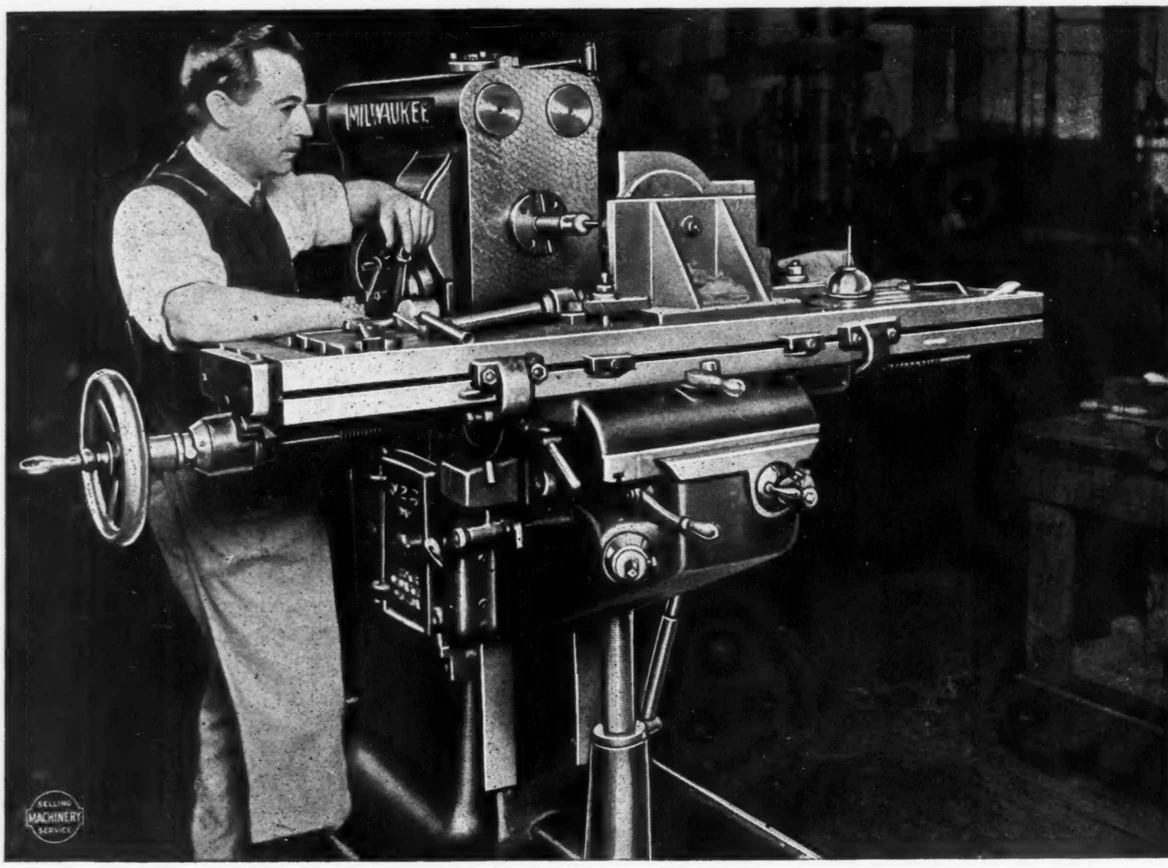
August 1917

Volume 23 Number 12

THE INDUSTRIAL PRESS, Publishers, 140-148 Lafayette Street, New York City



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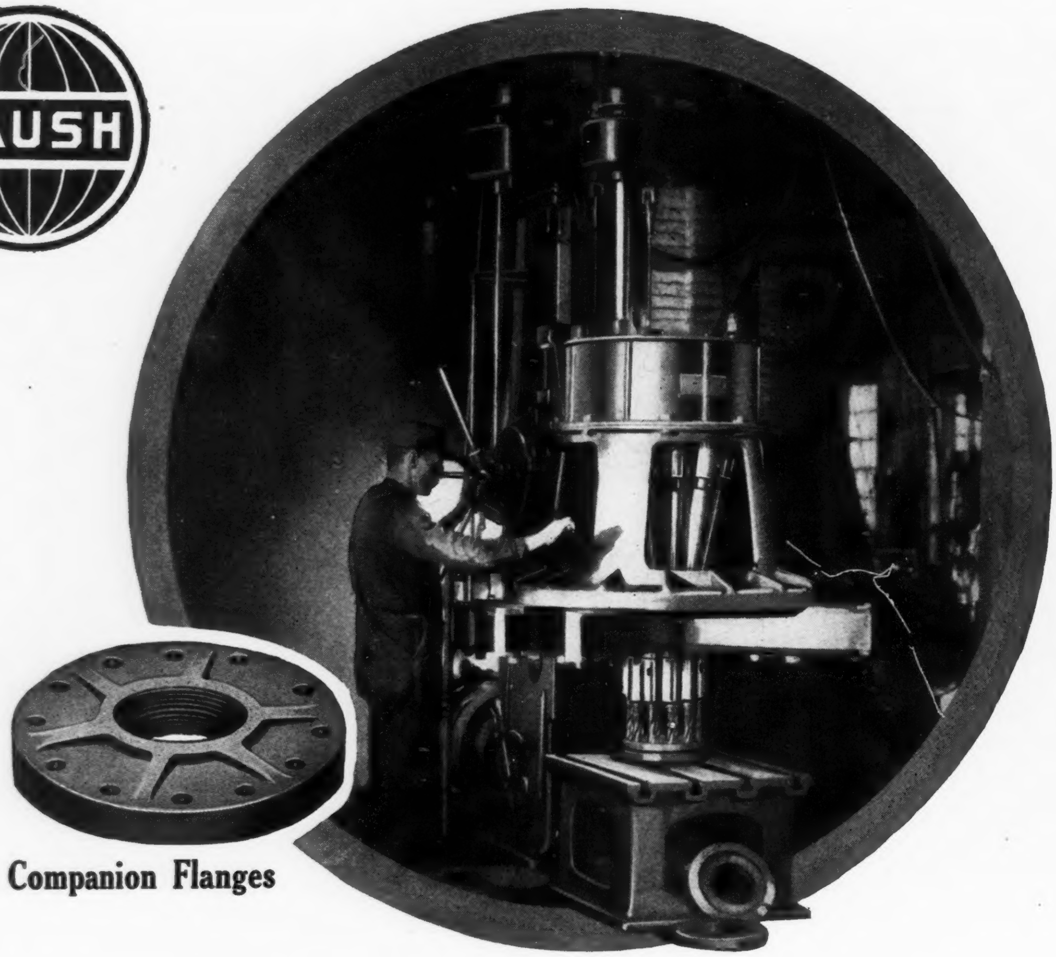
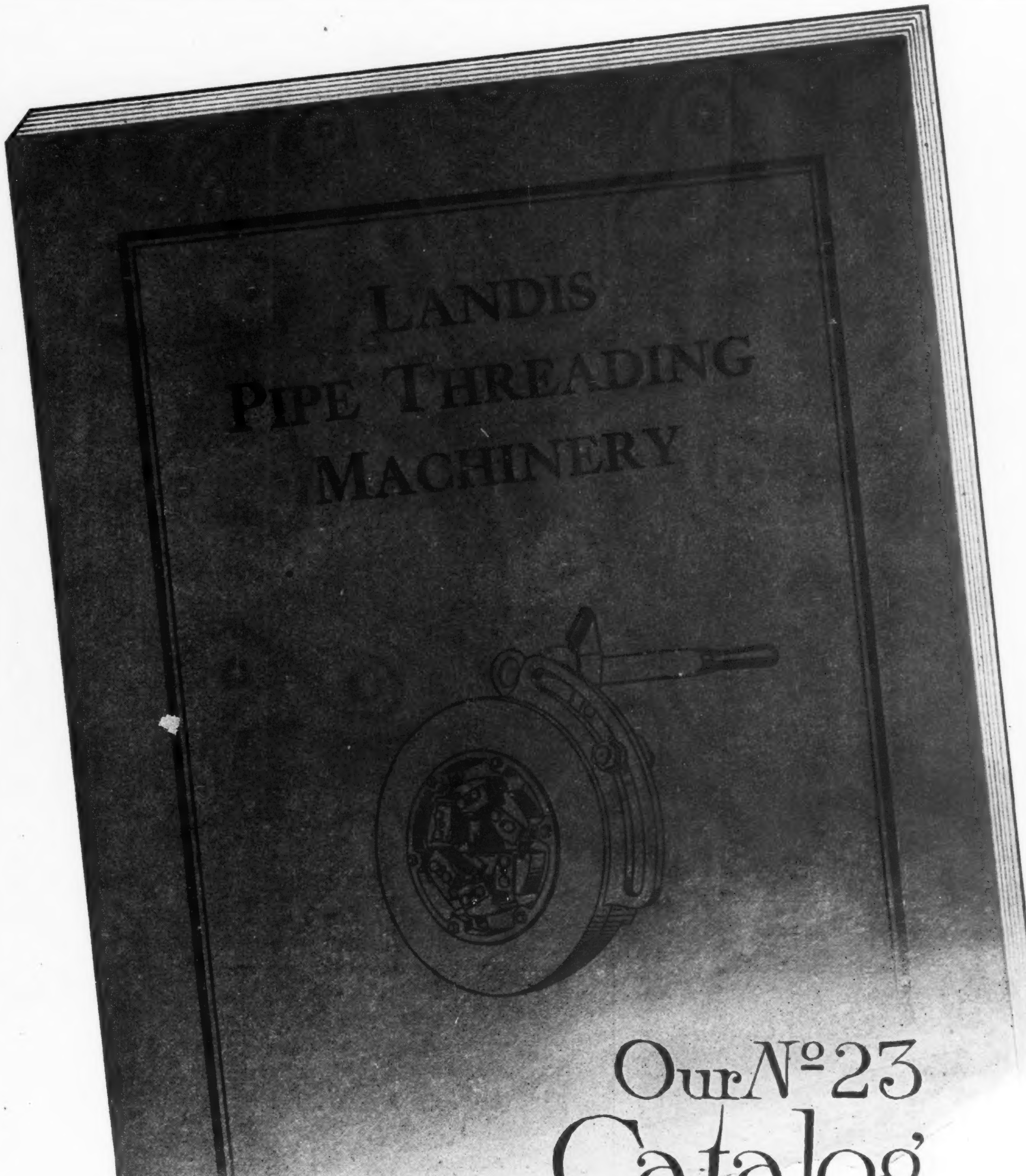


Companion Flanges



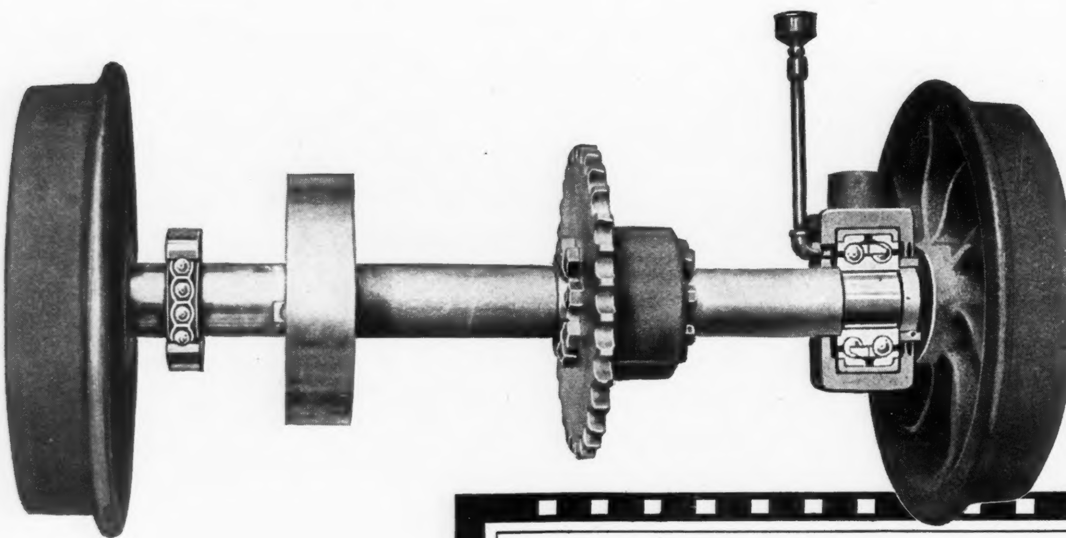
Our No. 23 Catalog is Now Ready for Distribution

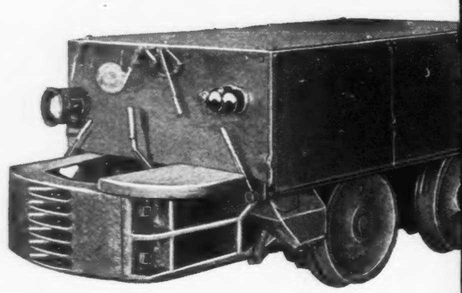
It lists the Landis "Pipe Threading Line"—Pipe and Nipple Threading Machines, Pipe Threading and Cutting Machines, also the Landis Chaser Grinder. Well illustrated with diagrams and detailed descriptions to show the advantages of Landis Chaser and Die Head design, construction, etc.

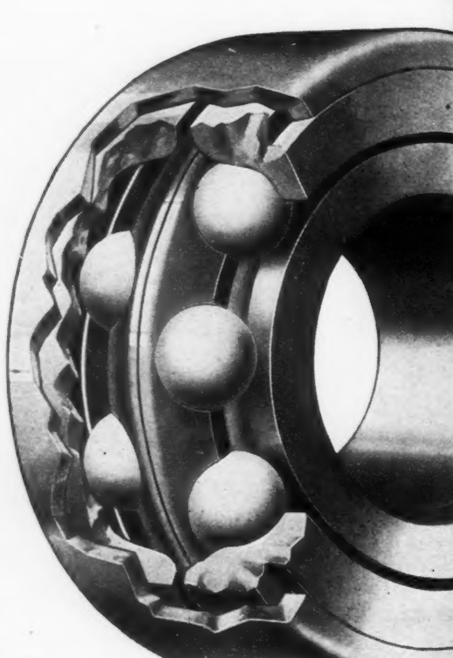
If you have not already received a copy your name is not on our lists. You should write us at once—a post card will do.

LANDIS MACHINE COMPANY, Inc.

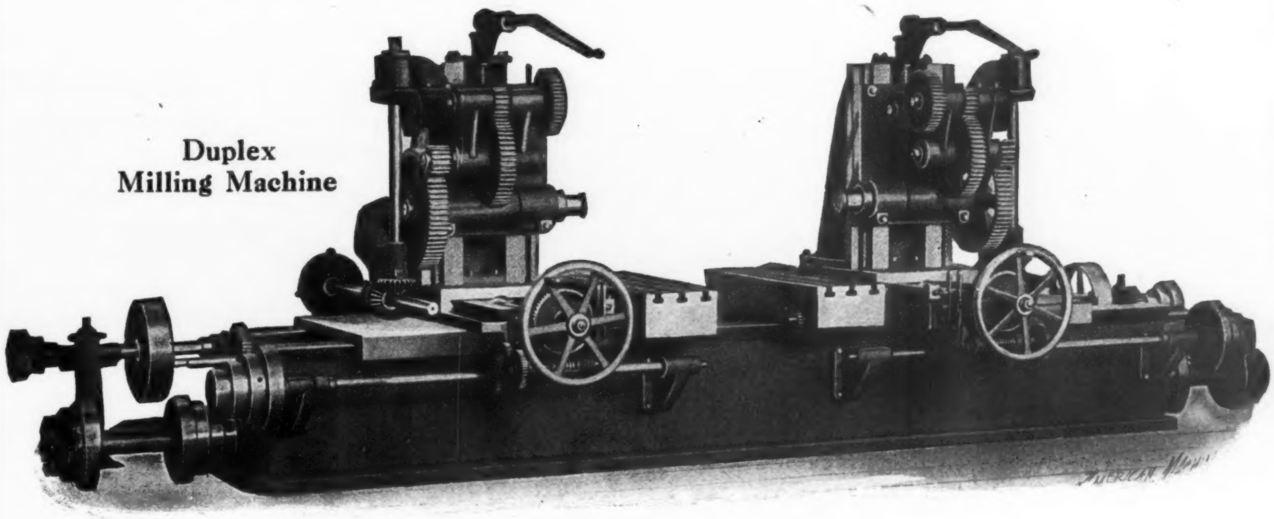
WAYNESBORO PENNSYLVANIA, U. S. A.







Duplex
Milling Machine

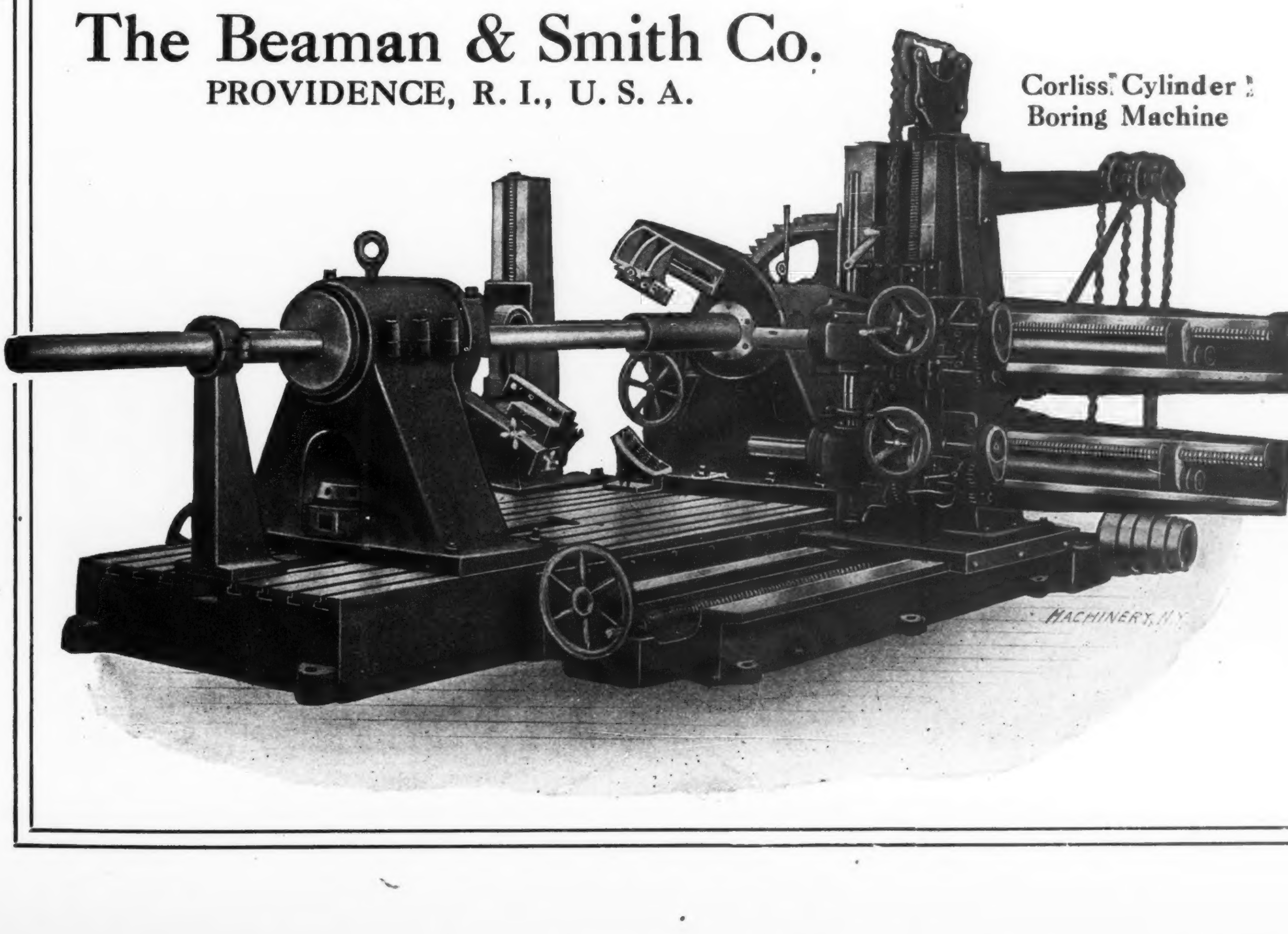


If You Want Higher Production
Consult Beaman & Smith

We design and build machines for accuracy, speed, ease of operation, and to give long, efficient service—machines capable of putting through several parts at one setting or performing several operations simultaneously. Consulting us involves no obligation. If you cannot use the machines we build to advantage we will say so frankly.

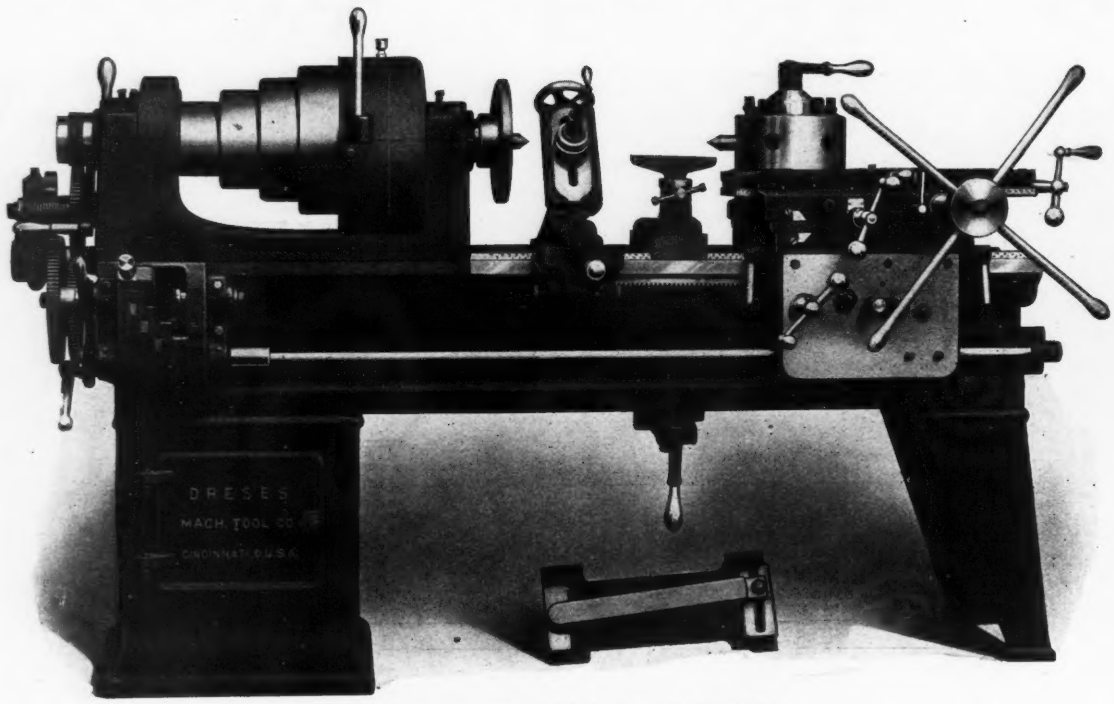
The Beaman & Smith Co.
PROVIDENCE, R. I., U. S. A.

Corliss Cylinder
Boring Machine



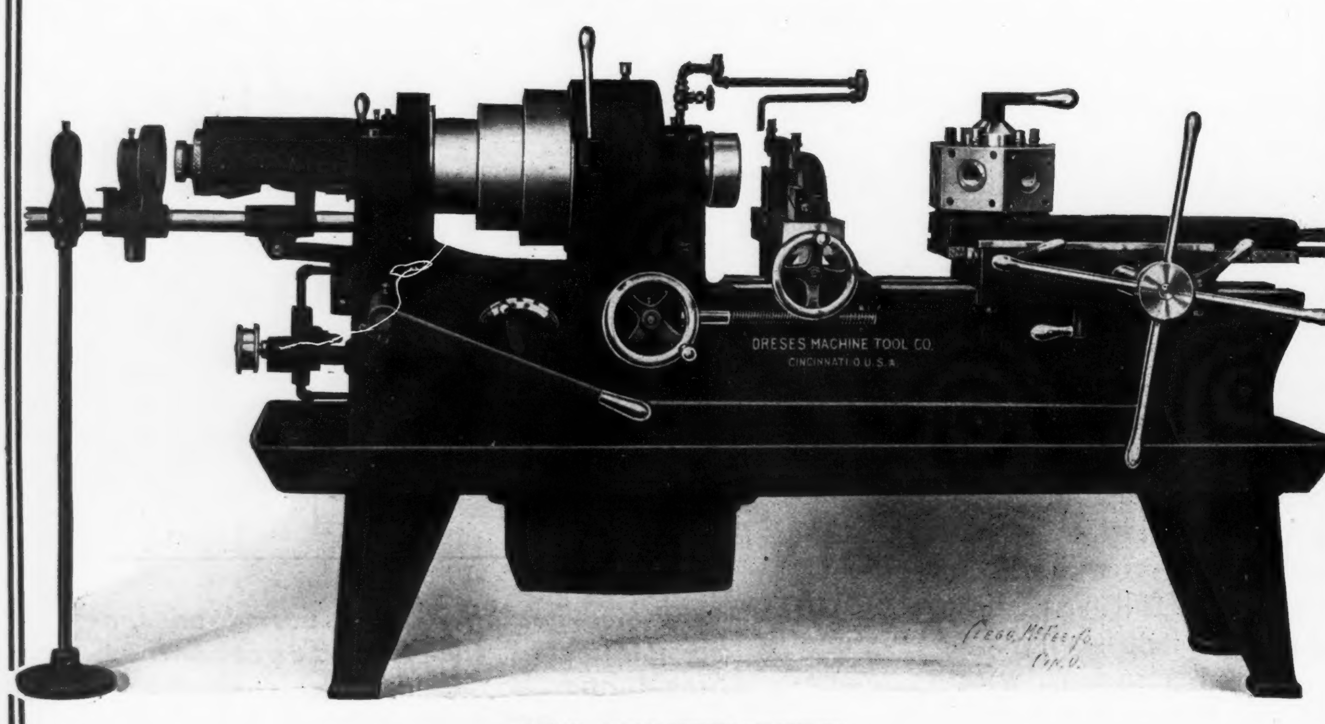
DESIGN and QUALITY

Distinguish our complete line of



14", 16", 18" and 20" UNIVERSAL MONITORS

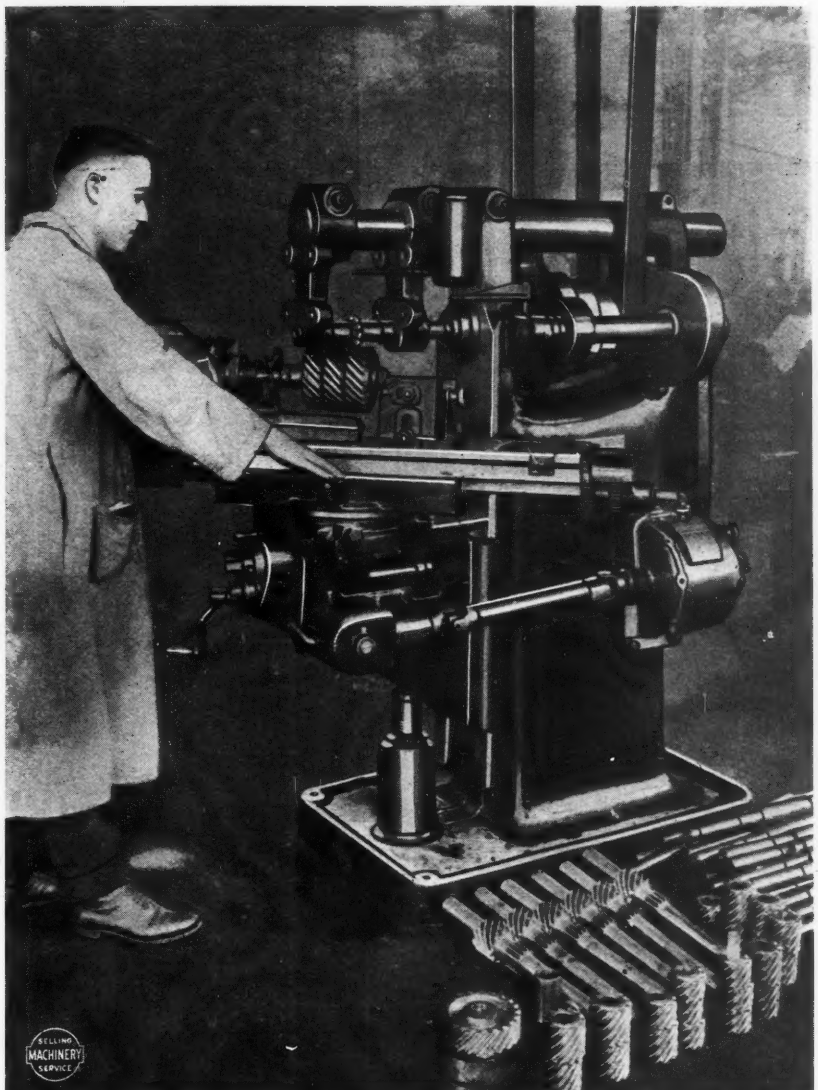
SCREW and TURRET MACHINERY

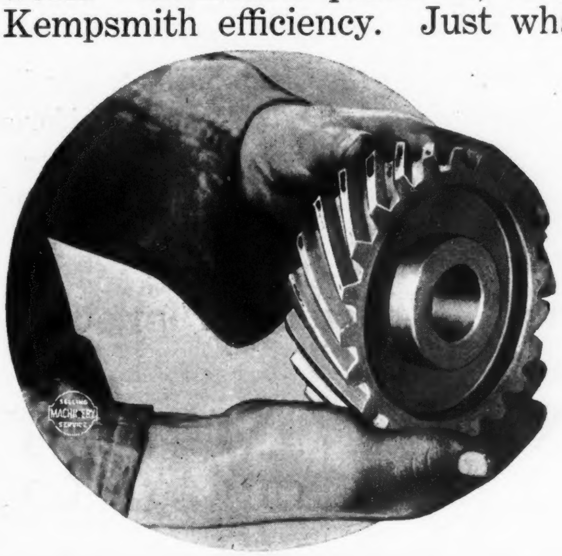


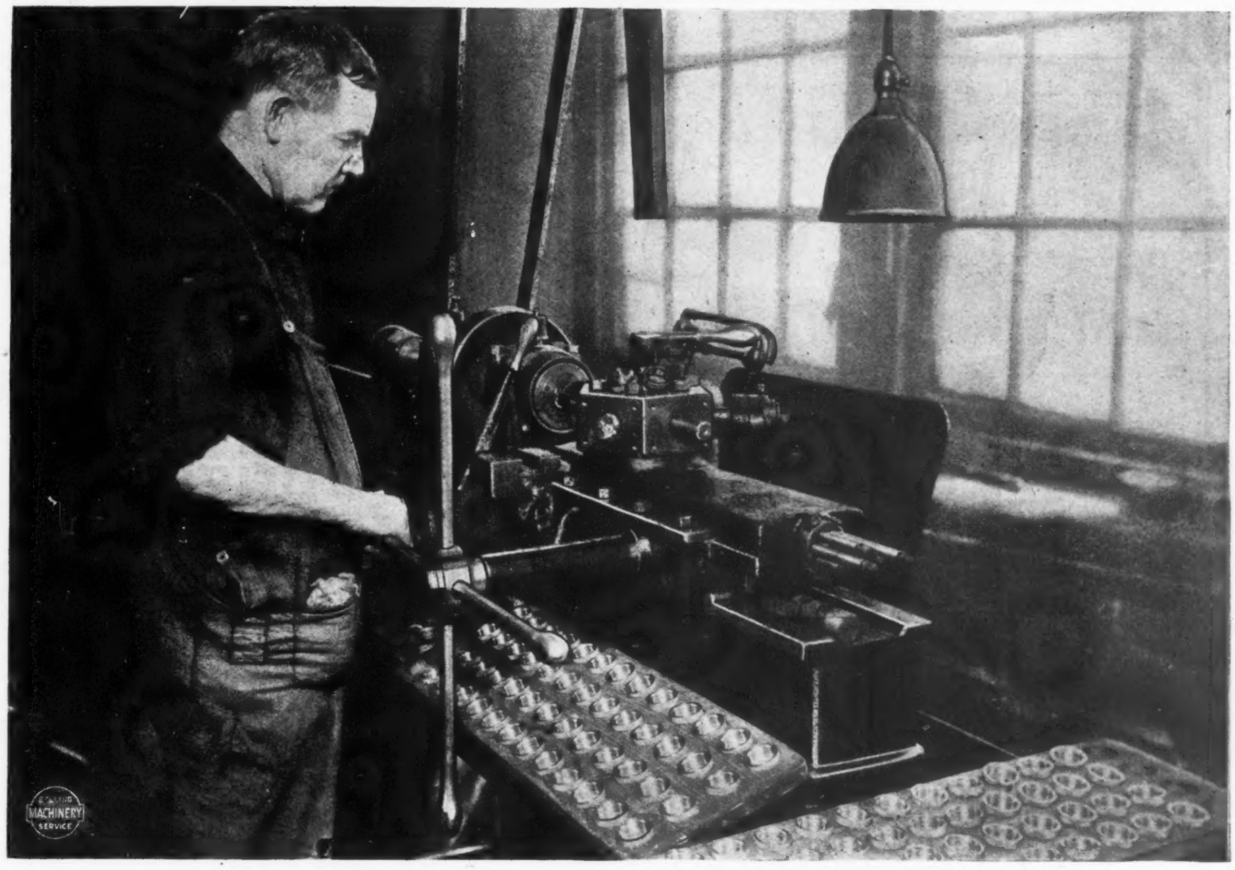
1", 1½" and 2¼" SCREW MACHINES

DRESES MACHINE TOOL CO., Cincinnati, Ohio

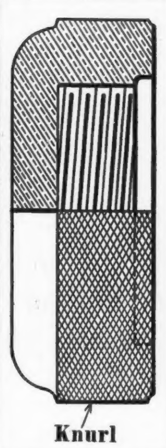
REPRESENTATIVES: The Fairbanks Co., New York, Boston, Philadelphia and Buffalo; Carey Machinery & Supply Co., Baltimore; E. L. Essley Machinery Co., Chicago; Badger-Packard Machinery Co., Milwaukee; William C. Johnson & Sons Machinery Co., St. Louis; The Chas. A. Strelinger Co., Detroit; Canadian Fairbanks-Morse Co., Montreal and Toronto; Selson Engineering Co., London; Stussi & Zweifel, Milan, Italy; Manning, Maxwell & Moore, Inc., Mexico City and Yokohama, Japan.







One Minute! Nothing, or a Lifetime!



Let us tell you more about the good features that make the Cincinnati-Acme Screw Machine a different lathe of this type.

In some forms of animal life a minute is an entire lifetime; in others it is nothing. It all depends upon what is done with, or in, the minute.

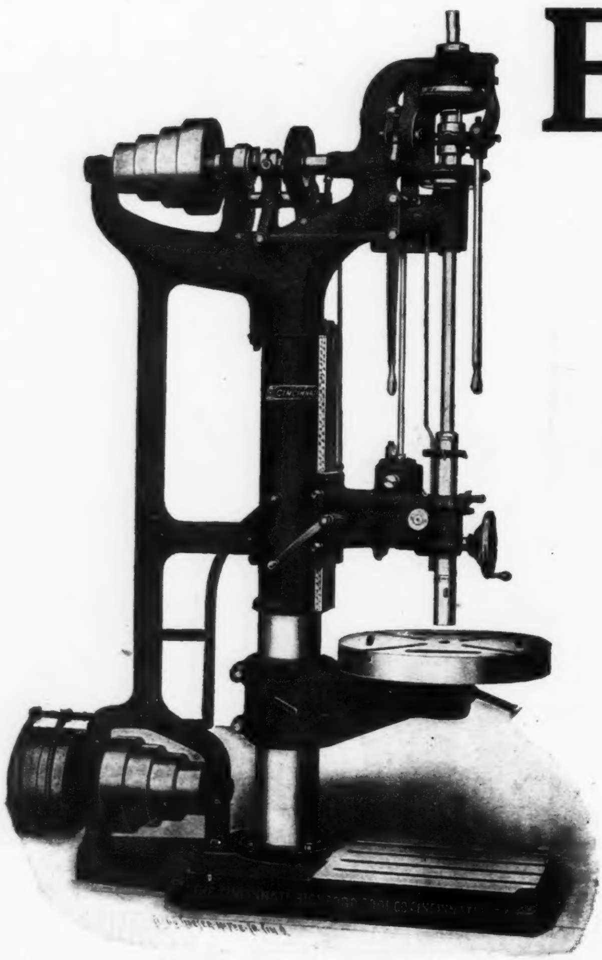
One minute is sufficient time in which to complete the second operation on this brass cap—turn, face and knurl—the work being held on a thread arbor.

The machine that makes such good use of a minute is a Cincinnati-Acme Screw Machine—and this is *average* time, output is 60 per hour, all day long.

This machine has been used by the Westinghouse Air Spring Co., New Haven, Conn., for a few months only; but this has been long enough to demonstrate its efficiency and economy over a wide range of work. And there are hundreds of concerns who have demonstrated the same things.

THE ACME MACHINE TOOL COMPANY

CINCINNATI, OHIO, U. S. A.



Built for

The Cincinnati Upright Drilling Machine

THE CINCINNATI

This Heavy Pattern Drill was designed for special purposes and its construction is vastly superior to the average. Study a few of its good points and you'll readily see why fine service comes so easy to the Cincinnati.

The frame is composed of a deep, well ribbed base, large accurately ground column, well shaped gear-guarded yoke, strong brace and conveniently located belt shifter. This built-in distinctiveness insures most profitable service and characterizes every part of the machine.

There are six positive, instantly available, feed changes, eight spindle speeds and a tapping attachment which acts through friction clutches and is operative at all speeds without shock or noise. This attachment possesses unusual gripping power, is adjustable, and may be disengaged when not in use. In addition to reducing tap breakage to a minimum it offers a convenient means for starting and stopping the spindle when changing tools.

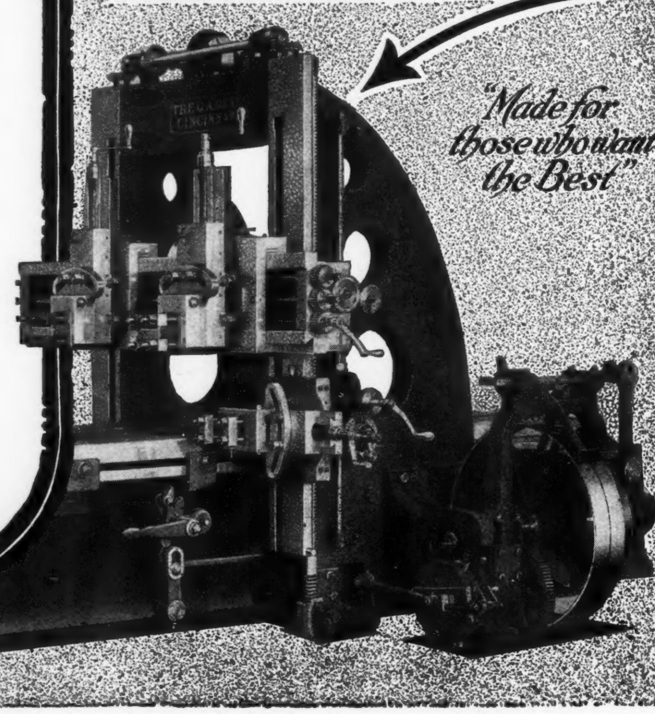
Many other features contribute their share toward fine service—adjustable table, counterbalanced head, automatic trip, elevating mechanism, bronze bushed bearings, etc.

For a complete description get our circular U-4A. Copy on request.

THE CINCINNATI BICKFORD TOOL

U-534

Gray Planers



Entire Drive Runs in Oil

One pair of bevel gears and one spiral pinion, all rigidly mounted and running in oil, constitute the driving mechanism of spiral-geared

Gray Planers

Write for catalog describing all of their exclusive features

The G. A. GRAY CO.
CINCINNATI, OHIO

Rigid and Accurate

The "Cleveland" Open Side Planers

will handle any and all classes of work equal to that done on any planer of any type.

With fewer working parts, it is the **SIMPLEST PLANER ON THE MARKET.**

All gears, in drive, except bull gear and its pinion are enclosed and run in oil.

Almost fool-proof.

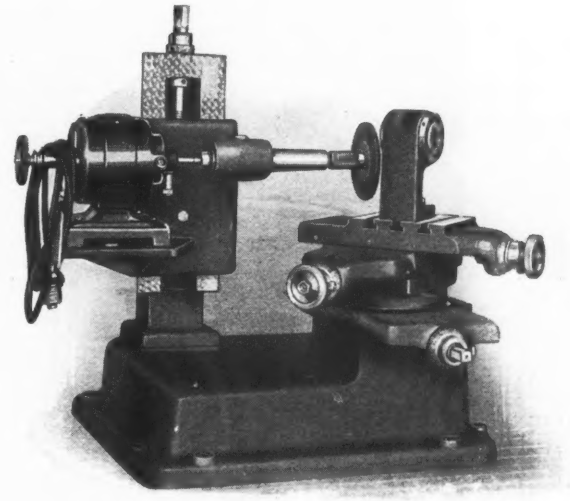
May we send you a catalog?

CLEVELAND PLANER WORKS

James G. Dornbirer
Geo. W. Ford

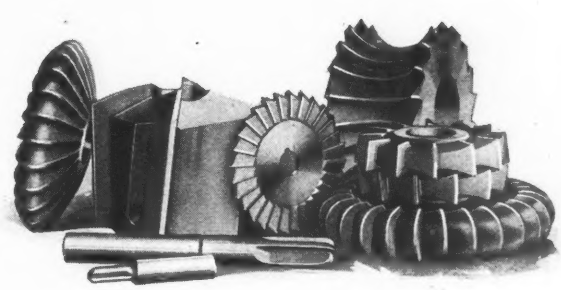
3150-3152 Superior Ave., CLEVELAND, OHIO, U. S. A.

The Cleveland Milling Machine Co.
PROFILE GRINDER



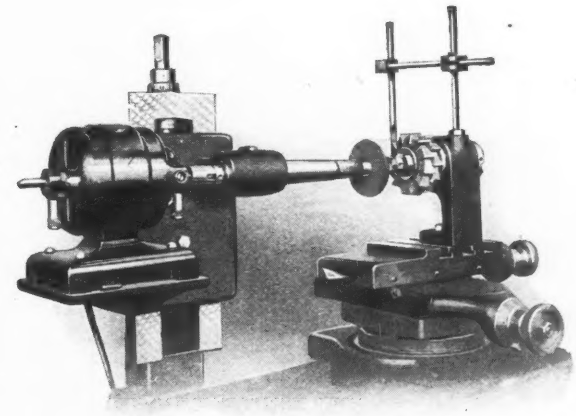
Is used to grind concave and convex cutters, cutters for fluting drills, cutters that are irregular but having a number of true curves, accurately rounding the corners on side mills and face mills, formed tools for lathes, planers and shapers.

The maximum radius that can be ground is 3 inches either convex or concave up to 12″ diameter.



The center cut shows a variety of formed cutters accurately ground on this machine. This, however, is only a small percentage of the uses that this tool can be put to. Users are finding it indispensable in the tool room.

The wheel carrying spindle is direct connected onto the motor shaft and has adjustable bronze bearings and carries a wheel 4″ diameter, ¼″ wide, ⅜″ hole.

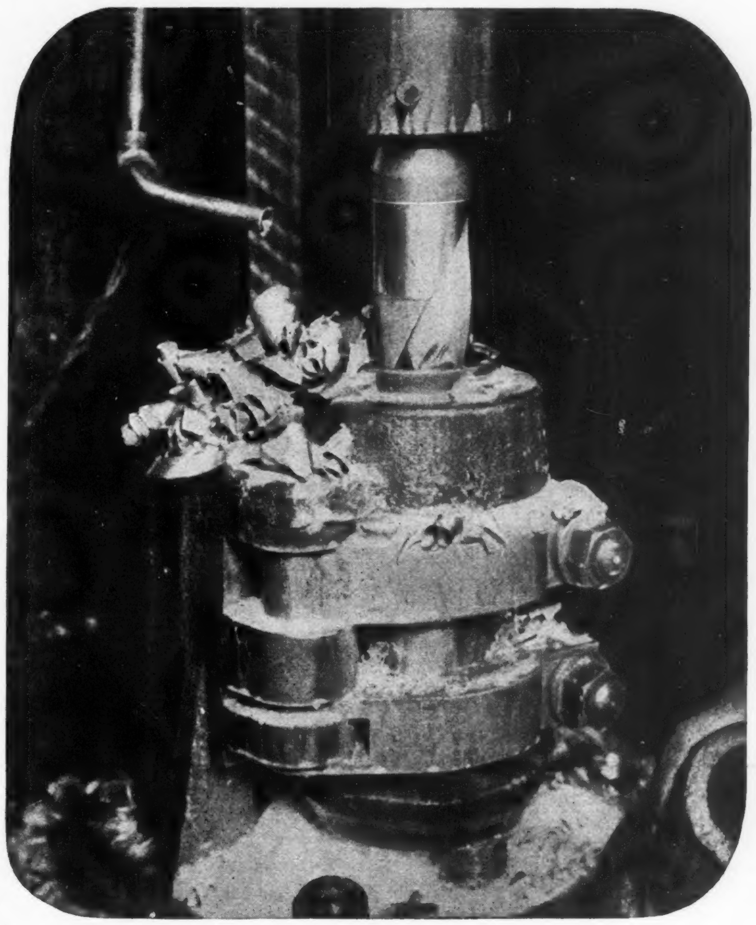


A type "D" Universal Dumore motor is furnished with ten feet of wire and lamp socket.

Complete equipment is furnished for all classes of work.

Immediate delivery if you get your order in now.

The Cleveland Milling Machine Co.
18511 EUCLID AVENUE CLEVELAND, OHIO



Standing Up—

Under Fifteen Thousand Pounds

A $1\frac{1}{4}''$ drill should not break under *ordinary* conditions. But have you any idea of the tremendous stress it often undergoes in eating its way through the metal?

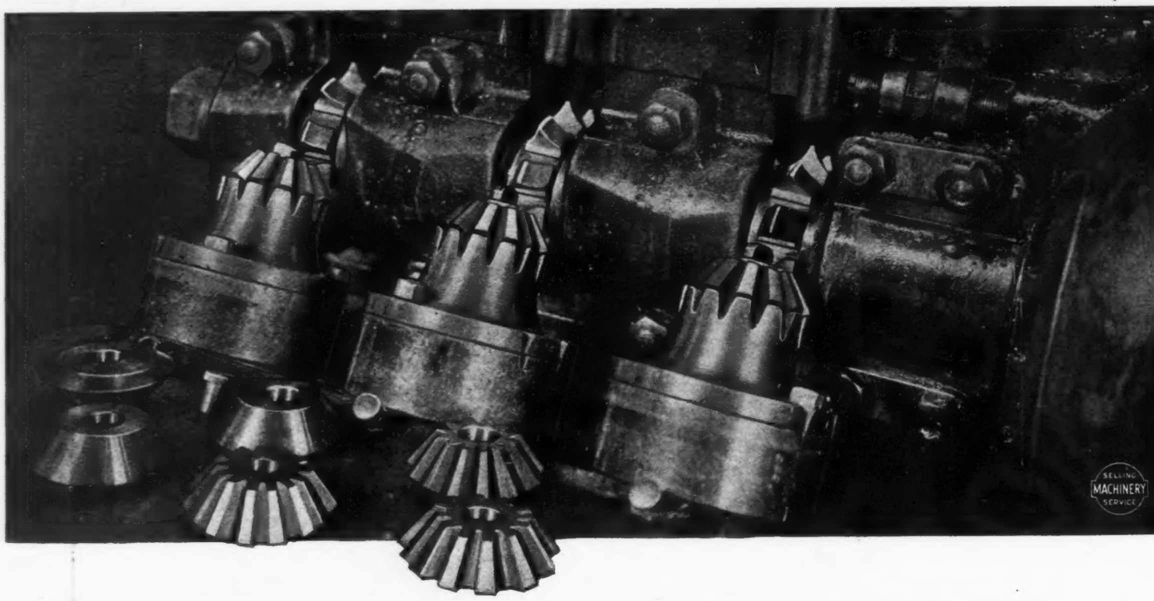
Add fifteen thousand pounds of vertical thrust to the grinding resistance and you have a fair idea of the kind of material and skill that make Union Twist Drills stand up.

Cutting coolly and rapidly, and with minimum wear, is a result that can come only from the broadest knowledge of tool requirements, together with the most scientific methods of material selection and manufacture.

The Union catalog also shows the full line of Union Tools—shall we send a copy?

UNION TWIST DRILL CO.

ATHOL MASSACHUSETTS



Roughing Out Bevel Pinions on a
G & E Multiple Spindle Gear Cutter

An average production of 300 pinions per ten hour day is produced on this machine—Pinion is 12 tooth, $^6/_8$ pitch, $^3/_4$" face made of cold rolled steel.

In cutting 3 pinions at one time we treble ordinary production—Let us help you on your particular work with our experience.

Send us your blue prints. Increase your production.

GOULD & EBERHARDT

"HIGH DUTY" SHAPERS
AUTOMATIC GEAR AND RACK CUTTING MACHINERY

ESTABLISHED 1833 NEWARK, N.J. U.S.A.

Two High Grade Products

Each a "Top-Notcher" in Its Particular Field

Assembled, tested, supplied with "juice" and cranked for a run, the Peerless looks, and is, a quality car from stem to stern. Geometric Tools—Die Heads and Collapsing Taps—help make it so. They contribute threads of the highest grade, accurate, finely finished threads, cut with remarkable speed and economy. It happens to be an internal threading job we are showing this time—differential cages in which the hole is 2⅝″ diameter, and the U. S. S. 16 pitch thread is ⅝″ in length. Not spectacular threading this; but interesting to the production investigator because it shows how a wideawake concern secures results.

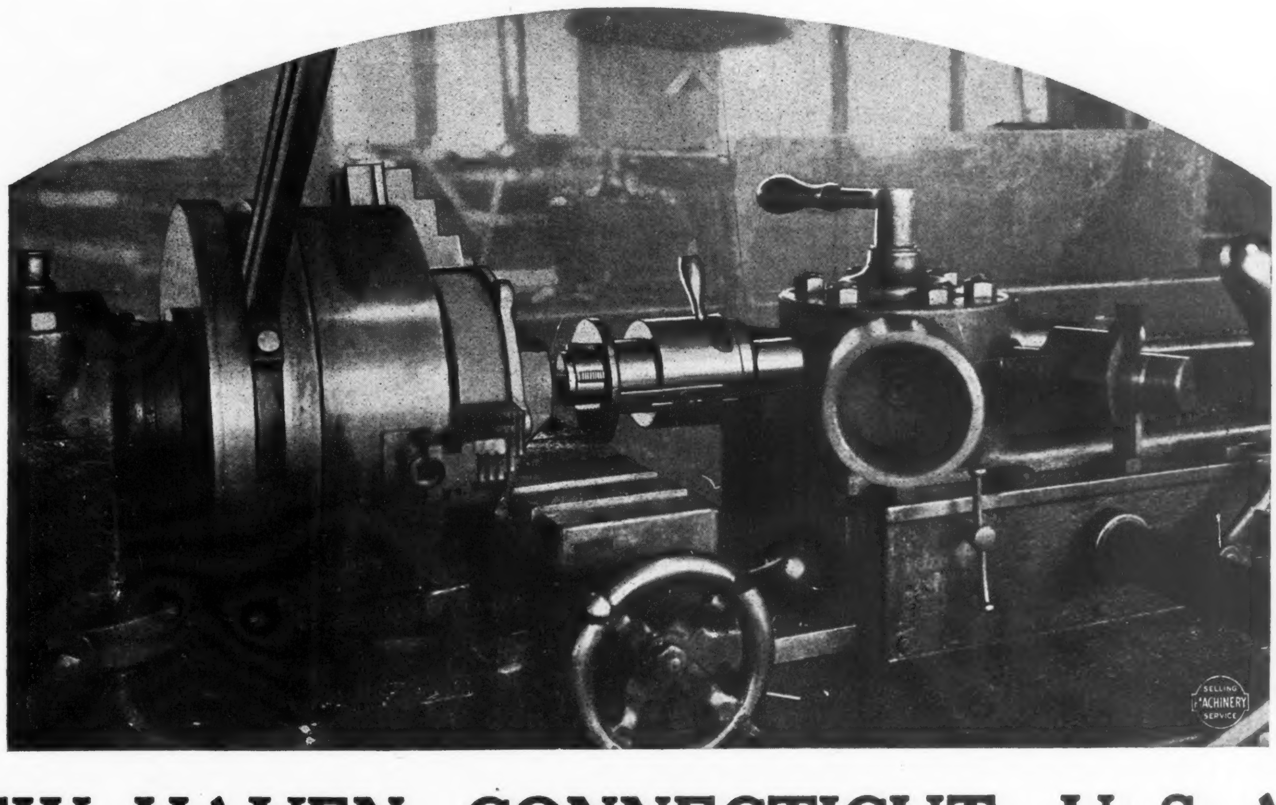
THE GEOMETRIC TOOL COMPANY

CHICAGO OFFICE:

REGULAR AGENTS: The Chas. A. Strelinger Co., Detroit, Mich.; Hill, Clarke & Co., Inc., Boston; Vandyck Churchill Co., New York and Philadelphia; Brown & Zortman Machinery Co., Pittsburgh, Pa.; The E. A. Kinsey Co., Cincinnati, O.; Strong, Carlisle & Hammond Co., Cleveland, O. **PACIFIC COAST:** General Machinery & Supply Co., San Francisco, Cal.; Perine Mchy. Co., Inc., Seattle, Wash. **CANADA:** The A. R. Williams Machinery Co., Ltd., Toronto, Winnipeg and St. John, N. B.; Williams & Wilson, Ltd., Montreal.

Geometric Die Heads

Geometric Tools are old timers with a record for universally efficient, economical service. They cut long, short, fine, coarse, tapered, inside or outside threads. Let us show how profitably they can cut threads for you. *Write for the Geometric Catalog.*



NEW HAVEN, CONNECTICUT, U. S. A.

545 W. Washington Blvd.

FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester, Newcastle-on-Tyne, Glasgow. Donauwerk Ernst Krause & Co., Vienna. V. Lowener's Maskinforretning, Sverre Mohn, Norway. Bevan & Edwards Pty., Ltd., Melbourne, and White & Rae, Sydney, Australia. Andrews & George, Tokyo, Japan. Also all manufacturers of Screw Machines and Turret Lathes.

SKF

Strong, Dominating, Steadfast, SKF Quality is one with its Fame

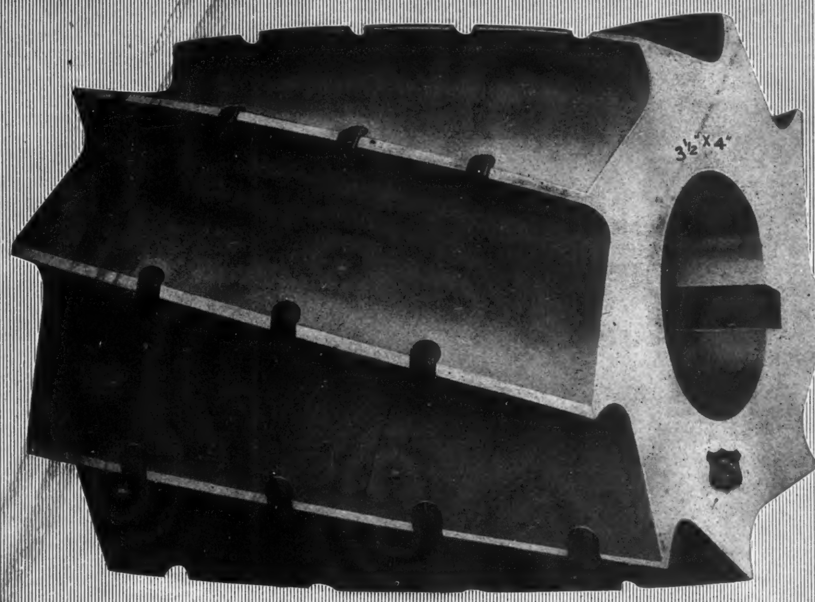
The machine tool user or manufacturer who demands quality—who wants materials and workmanship of the highest standards—will find SKF adequate to his most exacting requirements. No effort is spared, no precaution omitted, to maintain the excellence for which SKF is famous. The mark SKF is more than the name of a ball bearing—it is the visible symbol of excellence. This is why it stands at the forefront of machine tool progress.

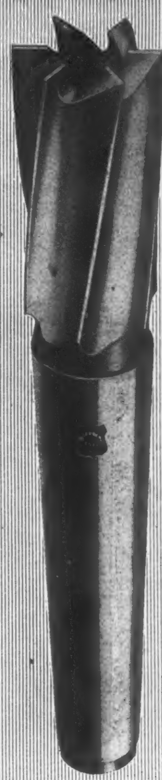
BALL BEARINGS

HARTFORD, CONN., U. S. A.

CANADIAN SKF CO., Ltd.
Toronto, Ontario
Canada

SKF
Hangers installed
in a large
machine shop





SHIELD BRAND MILLING CUTTERS

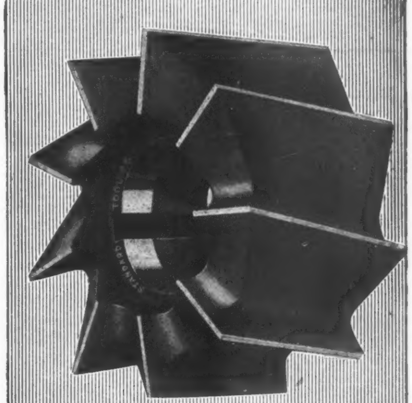
WITH WIDE-SPACED TEETH

THESE cutters are desirable where a large amount of metal is to be removed.

They will be found especially efficient in high power milling machines.

We make them in all styles and sizes.

Write for further information.

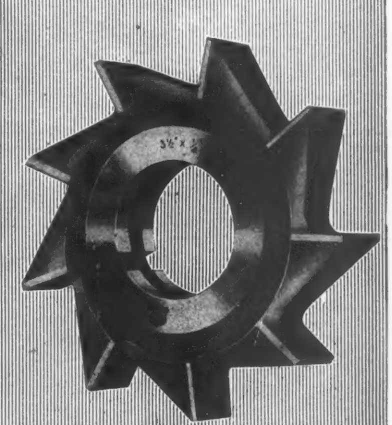


THE STANDARD TOOL CO.

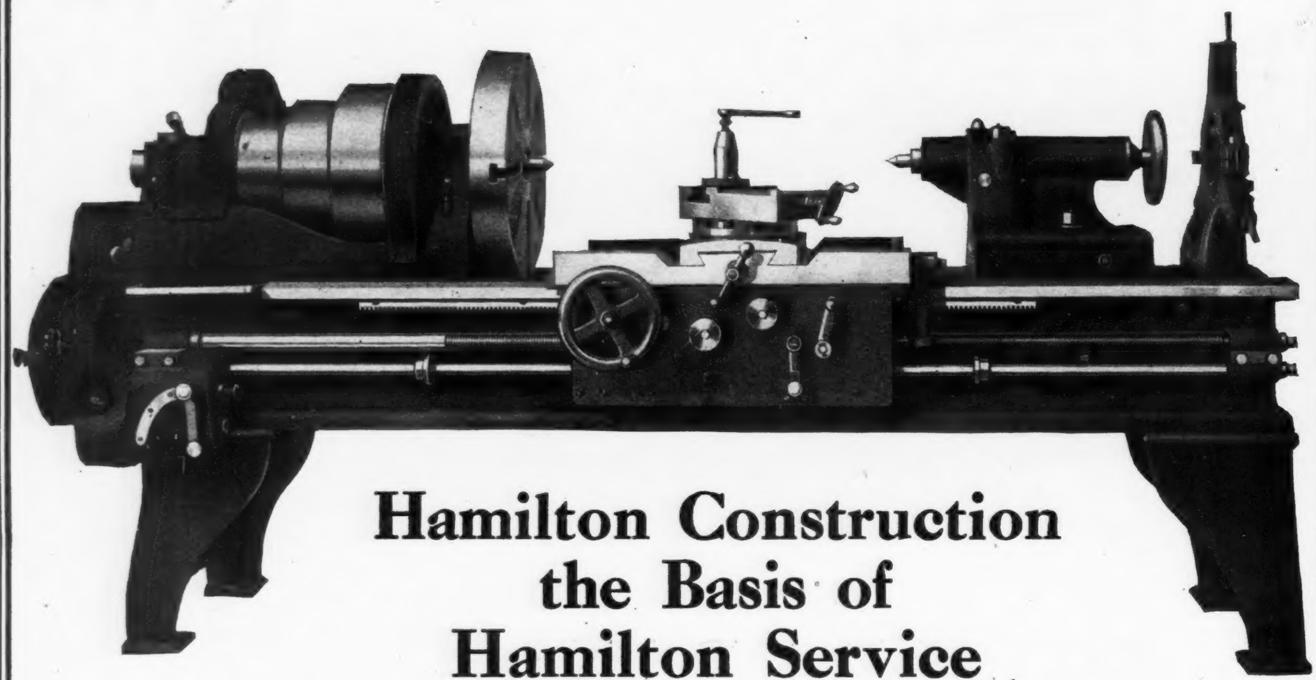
CLEVELAND—SIXTH CITY—U. S. A.

New York Store at - - - - - - - 94 Reade Street
Chicago Store at - - - - - - 552 W. Washington Blvd.

London—C. W. Burton, Griffiths & Co. - - - - Paris—Burton Fils.
Geneva—J. Lambercier & Co. - - - Brussels—Honore Demoor & Cie.
Copenhagen—Nienstaedt & Co. - - - - - - Tokyo—F. W. Horne.



"HAMILTON"



Hamilton Construction the Basis of Hamilton Service

We have built Hamilton Lathes on the theory that as a machine is made so will it perform. We wanted accuracy, so we centered on rigidity—made the Hamilton bed wide, deep, with heavy bracings, and backed it up with a headstock of massive and scientifically correct proportions. We wanted speed, so we provided tremendous driving power and operating helps of the simplest and most convenient kind. We have turned out a line of lathes that run second to none for capacity to turn out high grade work fast and keep everlastingly at it. The Hamilton spindle is forged crucible steel, bored its entire length, and accurately ground to size. Carriage is large, is securely gibbed front, center and back, scraped to solid bearing on bed its entire length and provided with power longitudinal and cross feed. All shafts and studs, lead screw, feed rod, and all rack and pinions are of high grade steel. All gearing accurately cut from the solid. All feeds are reversible from the apron.

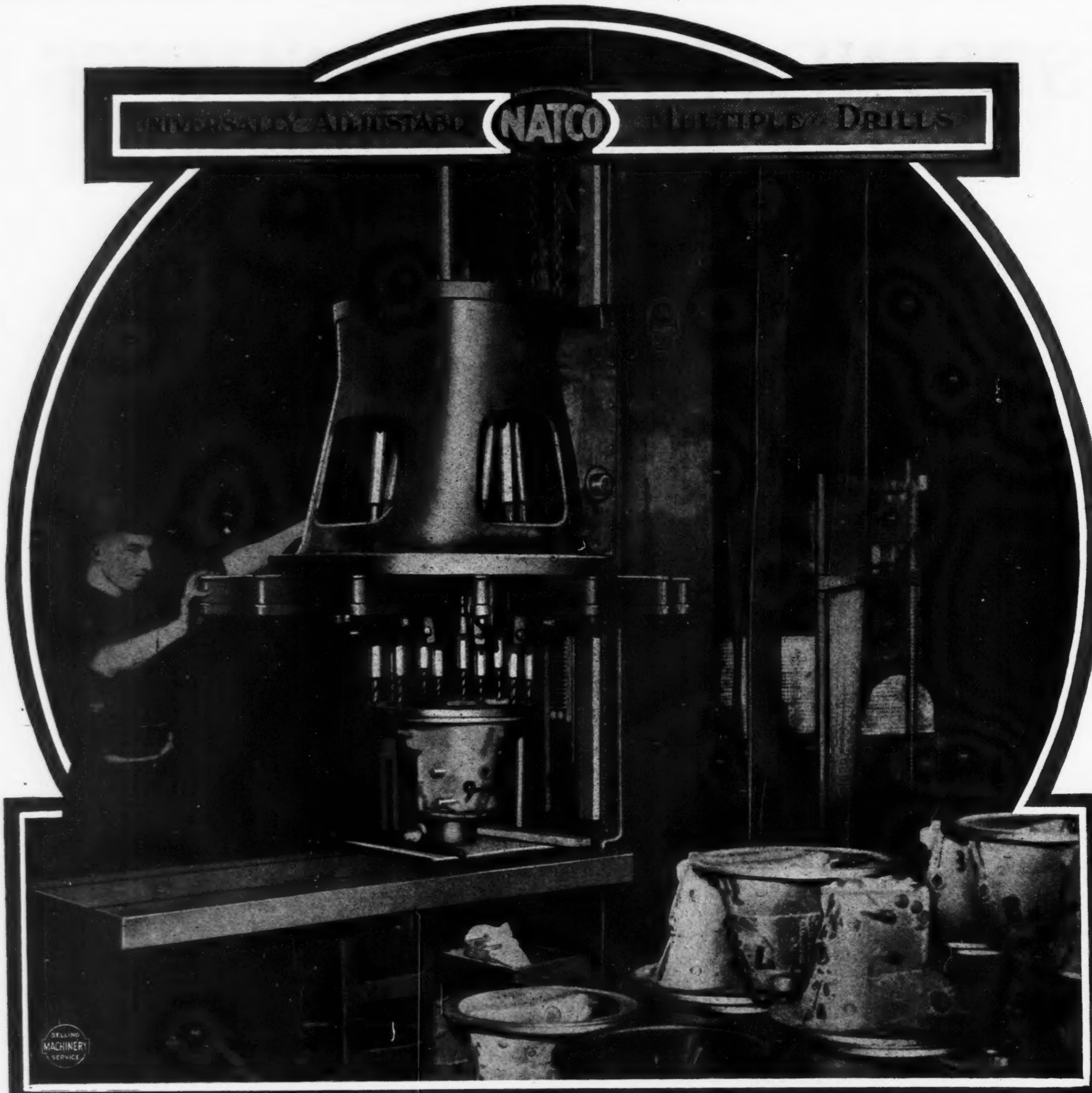
Your chief need just now is reliable equipment. We can take care of your Lathe and Planer needs. Write for details.

Rapid Production
HAMILTON
Machine Tools

THE HAMILTON MACHINE TOOL CO.

HAMILTON, OHIO, U. S. A.

DOMESTIC AGENTS: T. Crowther & Co., Inc.. Boston, Mass.; M. D. Farnum, Springfield, Mass.; Garvin Machine Co., New York; Strong & Hery Co., Rochester, N. Y.; Sherritt & Stoer Co.. Philadelphia, Pa.; Laughlin-Barney Mchy. Co., Pittsburgh, Pa.; Cullen Mchy. Co., Cleveland, O.; Osborne & Sexton Mchy. Co., Columbus, O.; Wolverine Machinery & Supply Co., Detroit, Mich.; Stocker-Rumely-Wachs Co., Chicago, Ill.; Thomson Tool & Supply Co., Indianapolis, Ind.; W. C. Johnson & Sons Mchy. Co., St. Louis, Mo.; F. E. Satterlee Co., Minneapolis, Minn.; Hendrie & Bolthoff Mfg. & Supply Co., Denver, Colo.; General Machinery & Supply Co., San Francisco, Cal.; Herberts Machinery & Supply Co., Los Angeles, Cal.; M. J. Walsh Mchy. Co., Milwaukee, Wis.; Textile Mill Supply Co., Charlotte, N. C.; Cotton States Belting & Supply Co., Atlanta, Ga.; Oliver H. Van Horn, Inc., New Orleans, La. CANADIAN AGENTS: H. W. Petrie, Ltd., Toronto, Ont.



Transmission Case Drilling—All on the NATCO

In the operation shown twelve 13/32-inch drills are used. The thickness of material is ½ inch. No lubrication. The operator completes this operation at the rate of thirty cases per hour. **All the drilling on this transmission case is done the NATCO way.** There are thirty-four holes in all, divided up into six operations.

The Durston Gear Co., Syracuse, New York, has another smaller NATCO drill—and each has been a profitable investment. The work done is performed at production figures as good as that quoted for this job—and the exclusive NATCO feature, independent speed adjustment for each drill, is one of the reasons.

If *you* would drill most economically do it the NATCO way. More details on request.

THE NATIONAL AUTOMATIC TOOL CO.

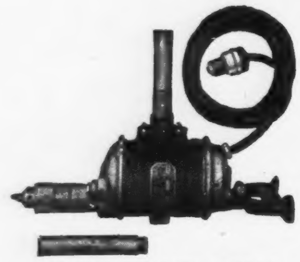
RICHMOND, INDIANA, U. S. A.

FOREIGN AGENTS: For British Isles: Burton Griffiths & Co., Ludgate Square, Ludgate Hill, London. For France: Aux Forges De Vulcain, Paris. For Germany: Heinrich Dreyer, Berlin.

IT'S UP TO YOU

To increase your Production and Reduce your Costs by installing "CINCINNATI" Portable Electrics

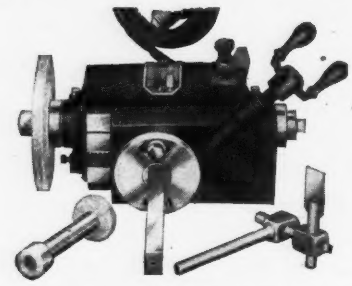
TRY THIS TRIO



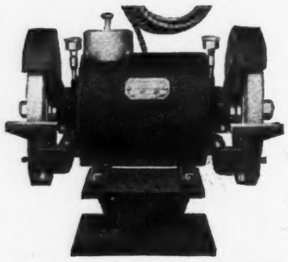
HAND OR BREAST DRILLS
¼", ⅜", ½", ¾" capacities. Weight from 7 pounds up. Gears run in grease. Single and two speeds.

SCREW-FEED DRILLS
¾" to 2" capacities.

SCOTCH RADIAL DRILLS
⅞" to 2½" capacities.



TOOL POST GRINDERS
¼ to 3 H. P. Weight from 16 pounds up. Free hand feed. Bearings adjustable to wear. Horizontal and vertical feeds. Different types for all purposes.



BENCH GRINDER OR BUFFER
Five sizes, ¼ to 3 H. P. Also Pedestal Floor Grinder 1 to 3 H. P. Fully enclosed. Dirt- and dust-proof. Ball bearings.

Special Features: *Air Cooled. Ball and Thrust Bearings. All working parts hardened. Overload Allowance. Guaranteed Mechanically and Electrically.*

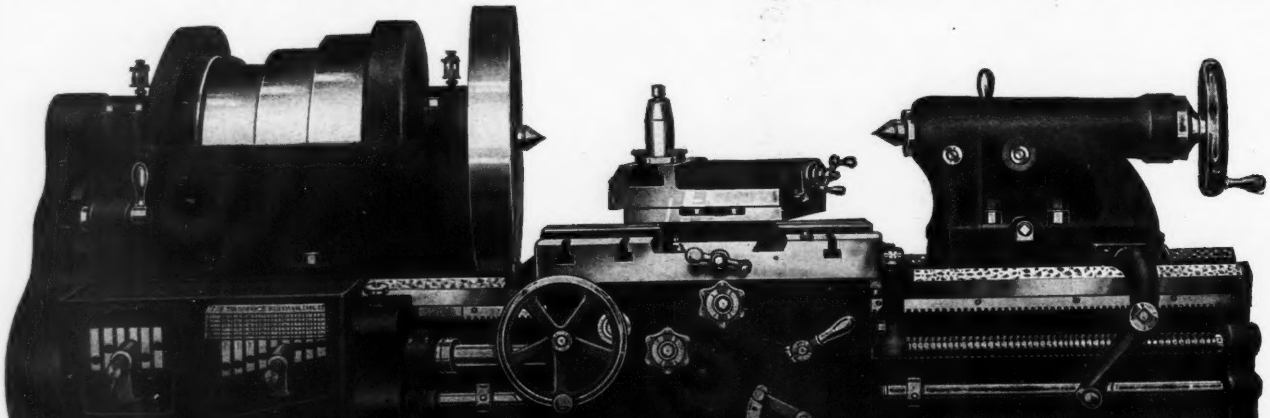
CINCINNATI ELECTRICAL TOOL CO.

650-652 Evans Street **CINCINNATI, OHIO**

FOREIGN AGENTS: England: S. Wolf & Co., London. **Australia:** Parke & Lacy Co., Ltd., Sydney. **Norway:** V. Lowener, Christiania. **France:** R. S. Stokvis & Fils, Paris. **Holland:** R S. Stokvis & Zonen, Ltd., Rotterdam. **Japan:** Yamatake & Co., Tokyo.

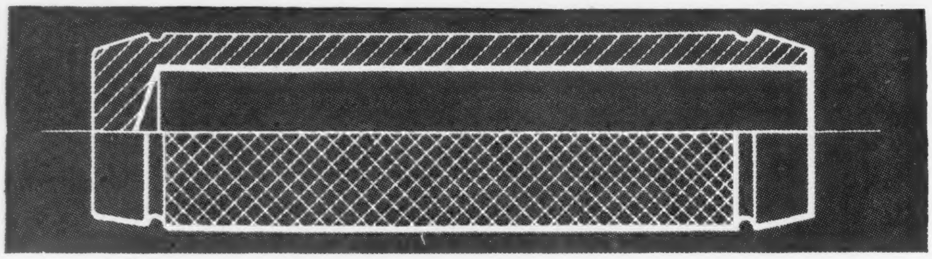
New York Office, 50 Church Street **Stock and Service Department**

G-K—MORE THAN JUST A LATHE



Most lathes are just lathes—nothing out of the ordinary, good enough for some purposes, most of them honestly built, but as like as peas in a pod. A G-K Lathe is different, different in important respects, in many details, in its very appearance. It is a better lathe—worth more because it can earn more—with an established company and years of experience behind it. Let us send the Booklet "G-K Betterments"—you'll find it worth studying.

THE GREAVES-KLUSMAN TOOL CO., Cincinnati, Ohio



One Every Two Minutes on the CLEVELAND AUTOMATIC

Consider the size and nature of this job, and the depth of the hole—then the 32 per hour rate at which the 1¼″ Model A Cleveland Automatic turns it out will give you an idea of what the machine can do for you. The piece shown above is knurled its entire length and tapered at both ends.

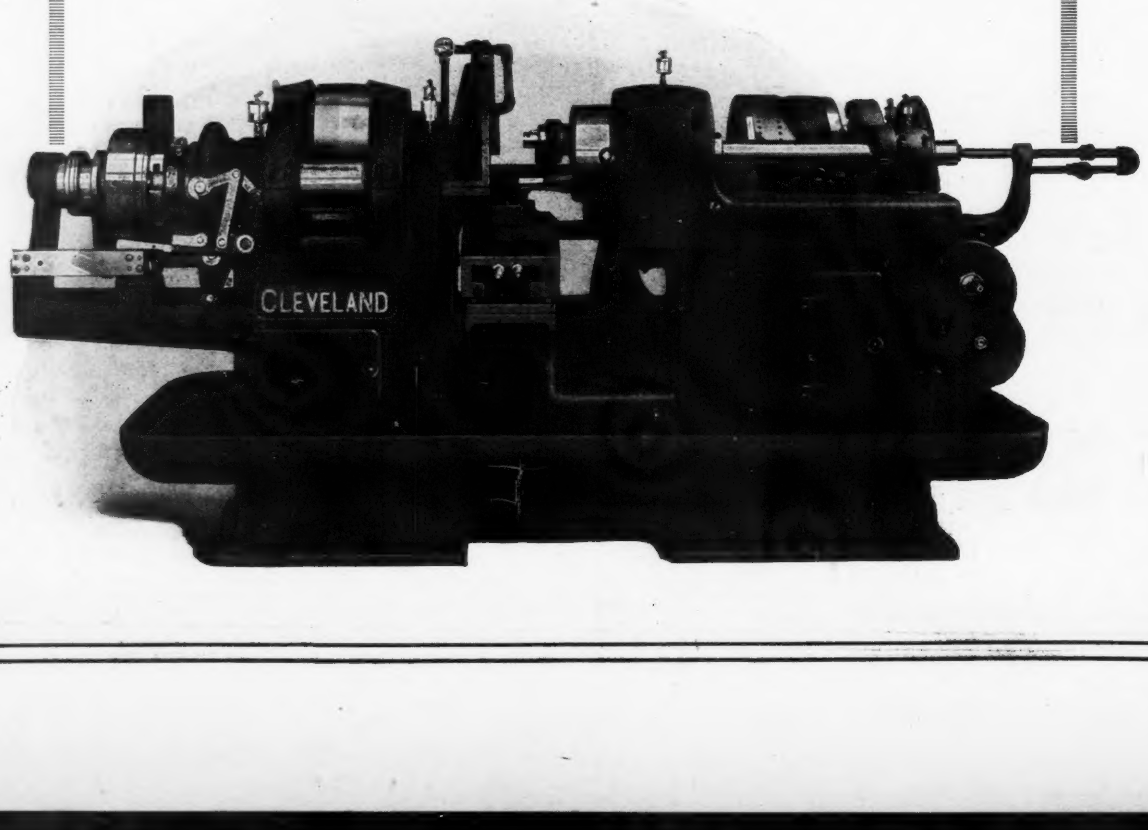
The tooling necessary on this job is as follows: Gauge stock to length; center for drill; drill half way and knurl full length; drill hole to full depth and form; cut off.

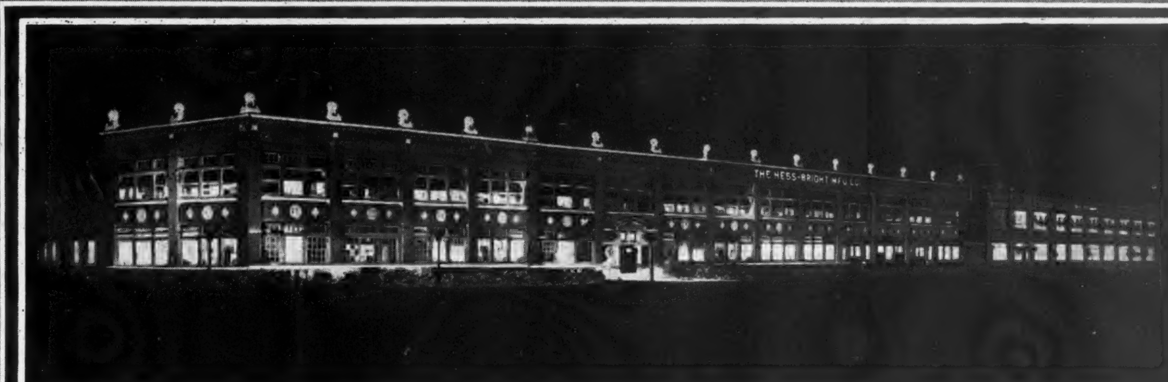
Fine finish, speed and accuracy with low labor cost are clearly defined advantages of Cleveland Automatic production. Let us give you conclusive proof.

Cleveland Automatic Machine Co.

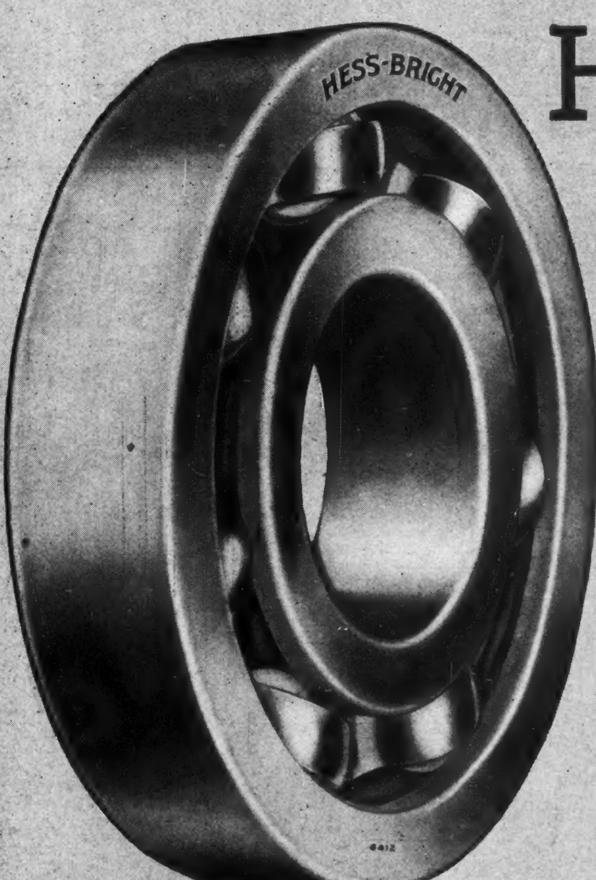
CLEVELAND, OHIO, U. S. A.

EASTERN REPRESENTATIVE: J. B. Anderson, 211 Gowan Ave., Mt. Airy, Philadelphia. WESTERN REPRESENTATIVE: Herbert E. Nunn, 565 West Washington St., Chicago. FOREIGN REPRESENTATIVES: Chas. Churchill & Co., Ltd., London, Manchester, Birmingham, Newcastle-on-Tyne and Glasgow.





HESS-BRIGHT
BALL BEARINGS



HAVE turned millions of revolutions on thousands of machines of hundreds of types for scores of purposes, standing millions of pounds of radial and thrust pressure.

They have done this in all climes, under varying conditions, with and without proper care, properly and improperly mounted or applied—*and they have stood up under it all.*

Thus they are carrying industry's burdens to the greater benefit of mankind.

Such is their reward. Their virtues have been proved. They have stood the test of time's worst task-master—Service.

Select the right Hess-Bright for *your* need and *your* bearing problems are solved. Let our engineers aid you in the solution of your problems.

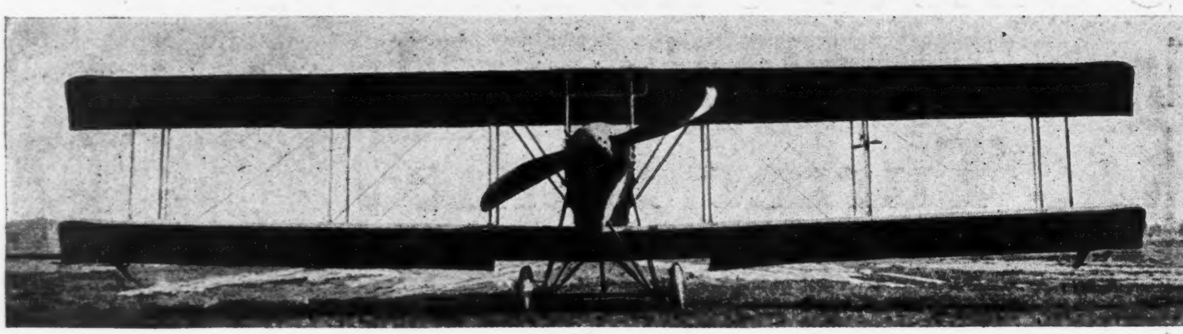
HESS-BRIGHT'S CONRAD PATENTS
ARE THOROUGHLY ADJUDICATED

HESS-BRIGHT MANUFACTURING COMPANY

FRONT STREET AND ERIE AVENUE ∴ ∴ ∴ PHILADELPHIA, PA.

THE TILTED TURRET

A CLEAR TRACK FOR THE STOCK



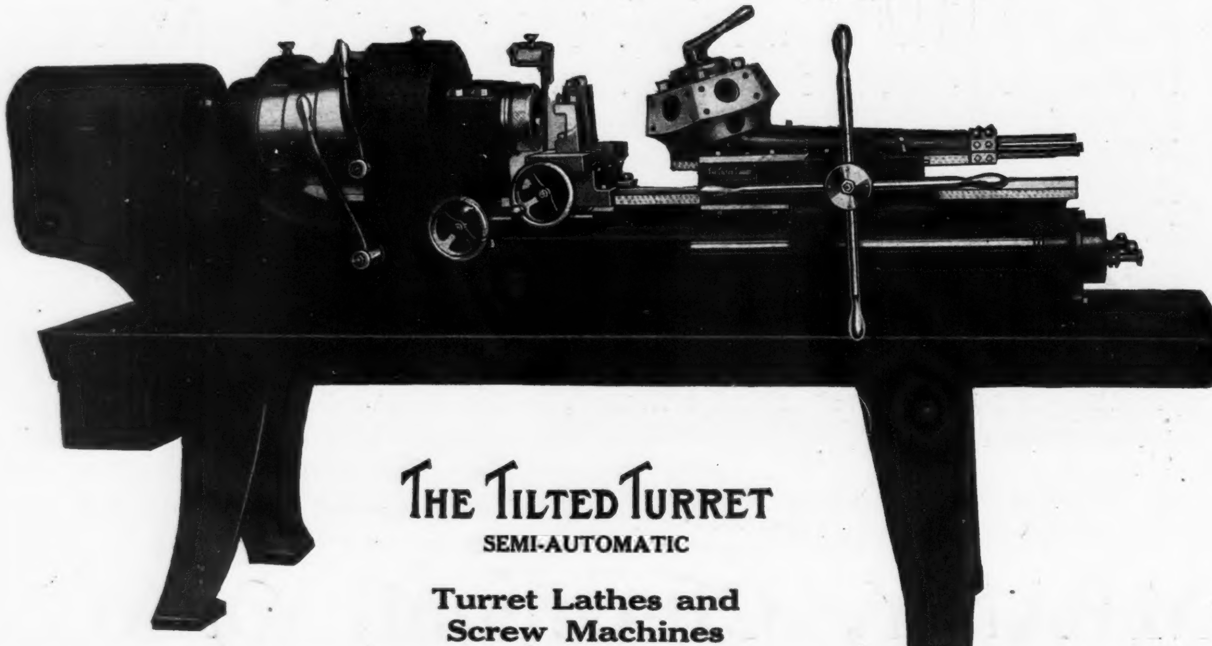
WHERE ACCURACY and DEPENDABILITY Are Vital Factors of Construction

ACCURACY is one of the most important and prime features of construction in airplane work. Mechanical parts are subject to the most rigid and minute inspection.

It is in this class of work THE TILTED TURRET excels. No matter whether your operations be on bar stock or chuck work, where duplicate parts are essential, you will find THE TILTED TURRET a superior machine tool. At the present time, a large portion of the entire production of THE TILTED TURRET is being purchased by airplane manufacturers, which proves its DEPENDABILITY. THE TILTED TURRET is fifteen years old and the duplicate orders prove its efficiency. Ask the user.

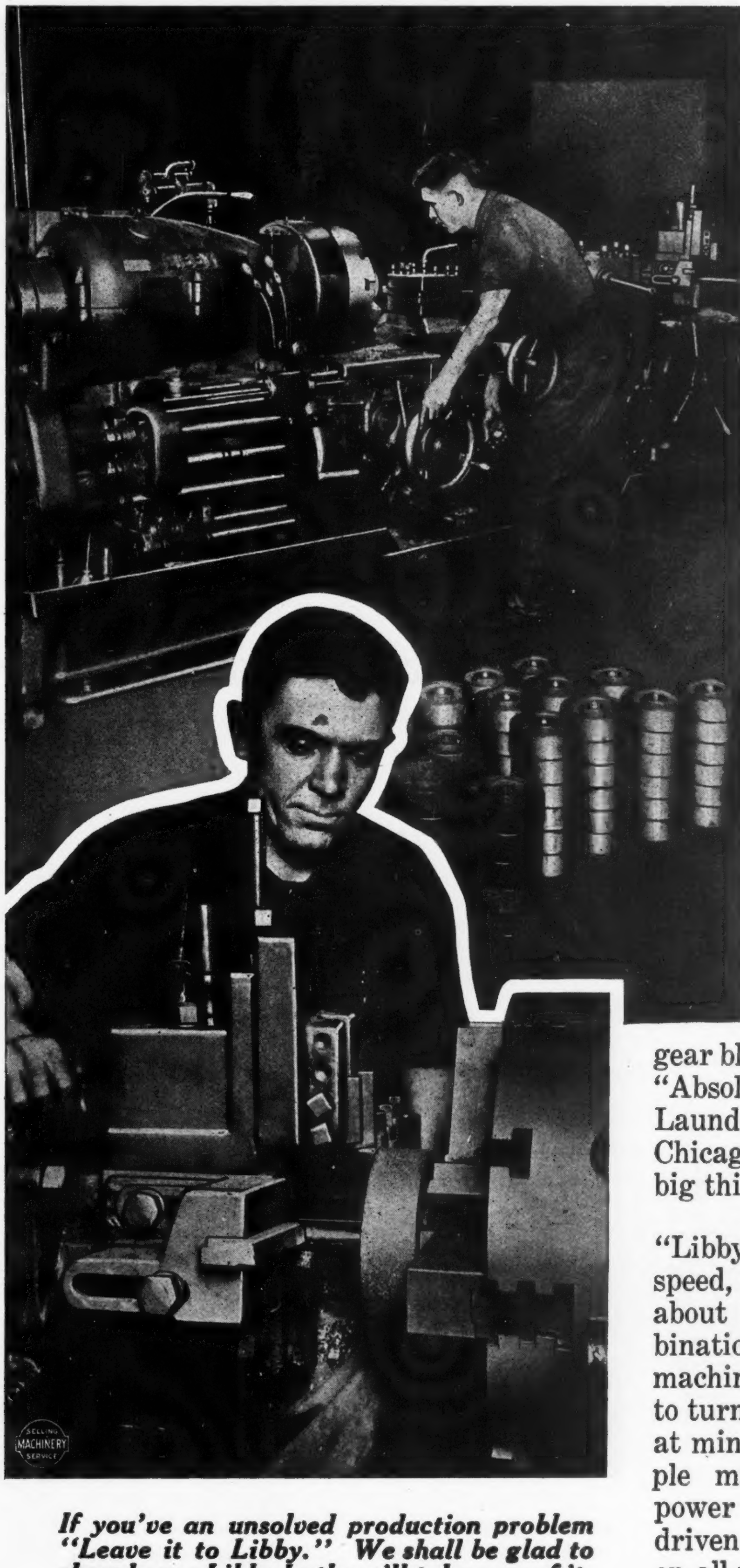
Do These Facts Interest You As a User or Prospective Purchaser of Turret Machinery?

Our Catalog M-19 describes methods of construction of THE TILTED TURRET as well as showing the various sizes and models we manufacture. Your copy awaits you.

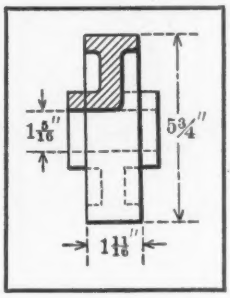


WOOD TURRET MACHINE CO.

BRAZIL INDIANA U.S.A.



Absolutely O.K.



"Leave it to Libby"

The work is gear blanks 5 3/4" diameter, 1 11/16" face, 1 5/16" bore; 3/16" stock is removed, two cuts are taken, two settings finish the job. Close accuracy and fine finish are observed, yet the Libby Lathe turns out a gear blank complete in *12 minutes.* "Absolutely O. K.," says the Troy Laundry Machinery Co., Ltd., Chicago, Ill.—and they demand big things of their machines.

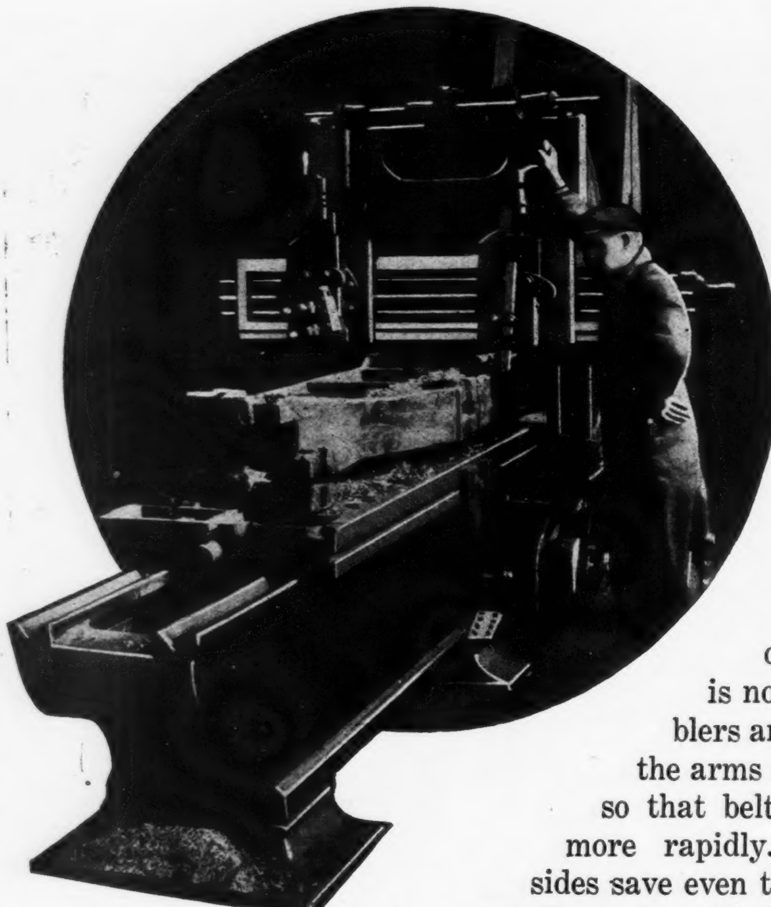
"Libby" users consider "Libby" speed, power, accuracy and range about the finest production combination on the market. These machines are designed and built to turn out the maximum of work at minimum cost. They are simple machines to operate, have power for heavy cuts, can be driven hard and are economical on all work they handle.

If you've an unsolved production problem "Leave it to Libby." We shall be glad to show how a Libby Lathe will take care of it.

INTERNATIONAL MACHINE TOOL CO.

INDIANAPOLIS, INDIANA, U. S. A.

DOMESTIC AGENTS: Bowman-Blackman Machine Tool Co., St. Louis, Mo. Brown & Zortman Machinery Co., Pittsburgh, Pa. Eccles & Smith Co., San Francisco, Cal.; Los Angeles, Cal.; Portland, Ore. E. L. Essley Machinery Co., Chicago, Ill., and Milwaukee, Wis. Strong, Carlisle & Hammond Co., Detroit, Mich., and Cleveland, Ohio. Vandyck-Churchill Co., New York, N. Y.; New Haven, Conn., and Philadelphia, Pa. Syracuse Supply Co., Syracuse, N. Y., and Buffalo, N. Y. **FOREIGN AGENTS:** Coats Machine Tool Co., Ltd., London, Eng. Ugo Violini & Co., Milan, Italy. Iznosskoff & Co., Petrograd, Moscow and Ekaterinburg, Russia.



The "OHIO" Planer Has Table Dogs and Shifter Levers on Both Sides

This feature is right in line with the high production principle so thoroughly developed in "Ohio" Planers. There is no lost motion between the tumblers and the belt shifter arms, and the arms are located close to pulley so that belt can be shifted much more rapidly. Levers on both sides save even the time it takes a workman to walk from one side to the other.

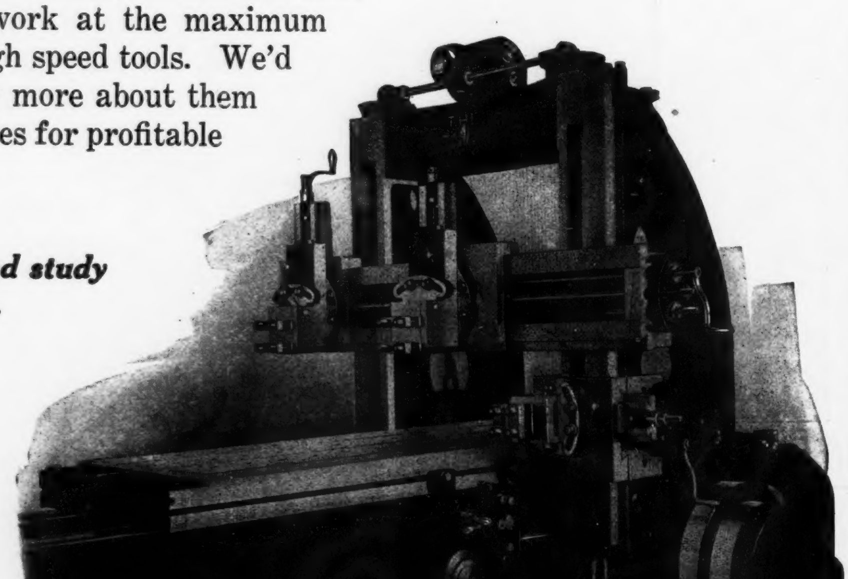
The "Ohio" represents the latest design in metal planing machines, and is built throughout for accurately machining the heaviest classes of work at the maximum capacity of high speed tools. We'd like you to know more about them and their possibilities for profitable service in your plant.

Send for the catalogue and study their many fine points.

OHIO MACHINE TOOL COMPANY

KENTON OHIO

Planers and Shapers Since 1887



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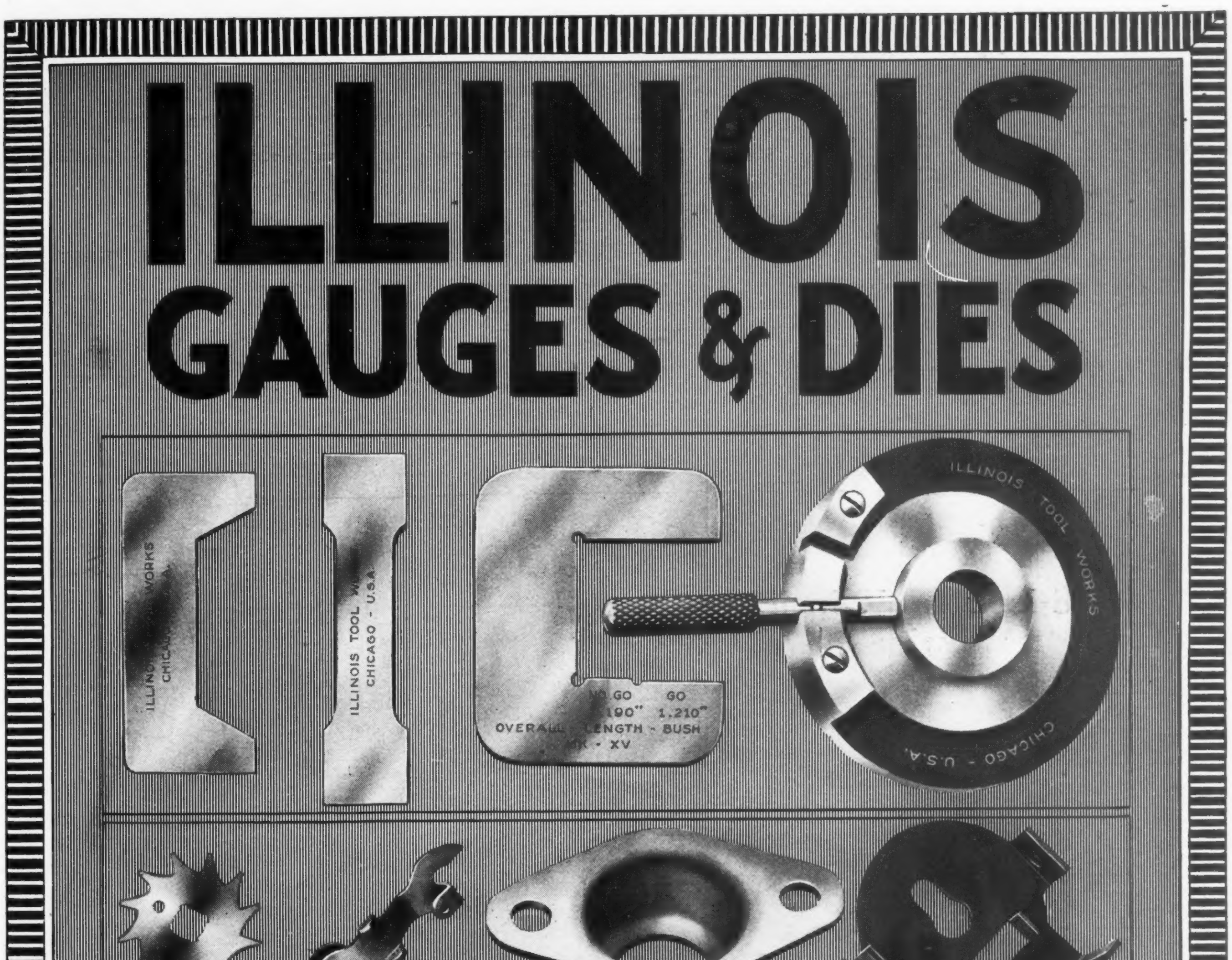
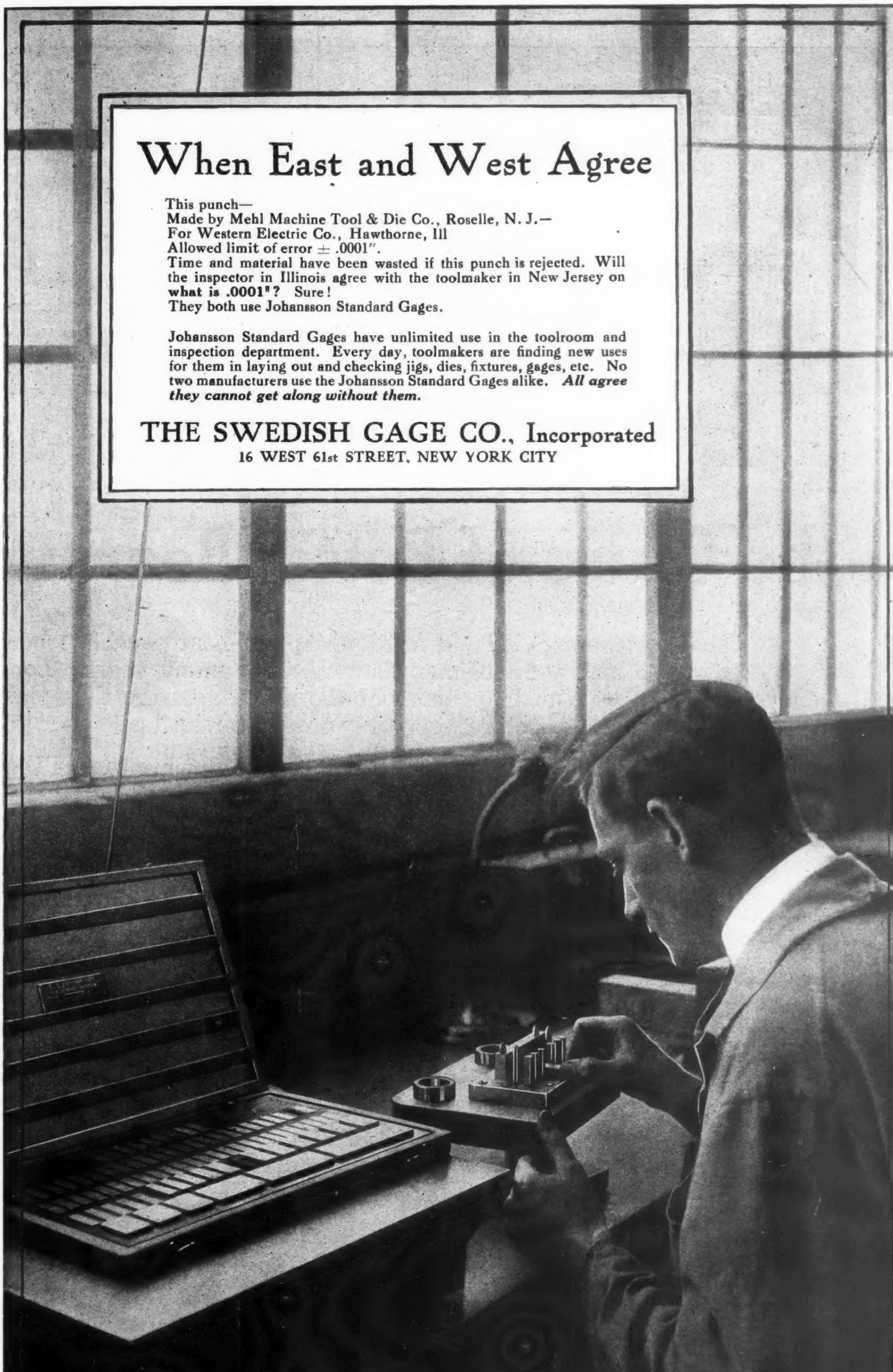
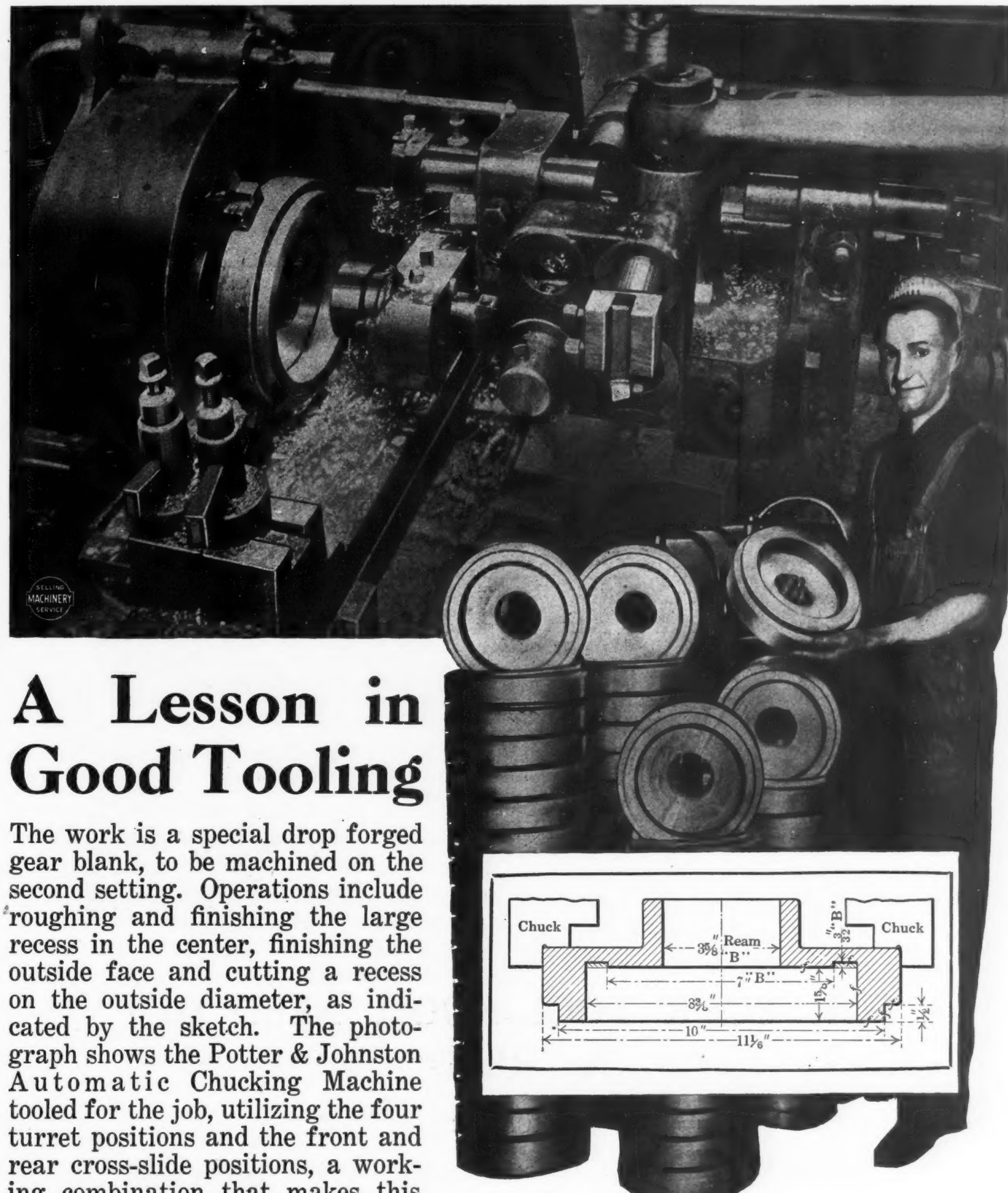

ILLINOIS
GAUGES & DIES
ILLINOIS TOOL WORKS
CHICAGO - U.S.A.
Illinois Gauges and Precision Tools are accepted as the standard of accuracy in numerous plants where the highest degree of exactness is required. For intricate Punch Press Work, Illinois Dies can be depended upon to produce uniformly perfect parts. Write or Wire for Quotations.
ILLINOIS TOOL WORKS, CHICAGO, U.S.A.
Manufacturers and Designers of Cutters—Hobs—Reamers


When East and West Agree
This punch—
Made by Mehl Machine Tool & Die Co., Roselle, N. J.—
For Western Electric Co., Hawthorne, Ill
Allowed limit of error ± .0001".
Time and material have been wasted if this punch is rejected. Will the inspector in Illinois agree with the toolmaker in New Jersey on **what is .0001"?** Sure!
They both use Johansson Standard Gages.
Johansson Standard Gages have unlimited use in the toolroom and inspection department. Every day, toolmakers are finding new uses for them in laying out and checking jigs, dies, fixtures, gages, etc. No two manufacturers use the Johansson Standard Gages alike. ***All agree they cannot get along without them.***
THE SWEDISH GAGE CO., Incorporated
16 WEST 61st STREET, NEW YORK CITY



A Lesson in Good Tooling

The work is a special drop forged gear blank, to be machined on the second setting. Operations include roughing and finishing the large recess in the center, finishing the outside face and cutting a recess on the outside diameter, as indicated by the sketch. The photograph shows the Potter & Johnston Automatic Chucking Machine tooled for the job, utilizing the four turret positions and the front and rear cross-slide positions, a working combination that makes this accurate bit of turning an exceedingly rapid performance.

Potter & Johnston—*The Manufacturing Automatic*

This machine can be tooled to handle work entirely outside the range of other lathes. All operations are automatic, one operator runs several machines; design is simple; machines are rapid, strong, durable and can be relied upon to lower costs. If the high cost of turning good work fast is one of your problems, write us.

POTTER & JOHNSTON, Pawtucket, R. I., U.S.A.

OFFICES AND REPRESENTATIVES: Office for Great Britain and France: 68 Avenue de la Grand Armee, Paris, J. Ryan, Manager. New York Office: Fulton Bldg., 50 Church St., Walter H. Foster Co., Managers. Detroit Office: Modern Machinery and Engineering Co., 1514 Ford Bldg. Chicago Office: 4213 Sheridan Road, Chas. H. Shaw, Manager, Toronto Office: 1501 Royal Bank Bldg., E. C. Roelofson, Manager. FOREIGN AGENTS: Chas. Churchill & Co., Ltd., London, Birmingham, Manchester and Newcastle-on-Tyne, England, and Glasgow, Scotland. Ercole Vaghi, Corso Porta, Nouva 34, Milan, Italy.

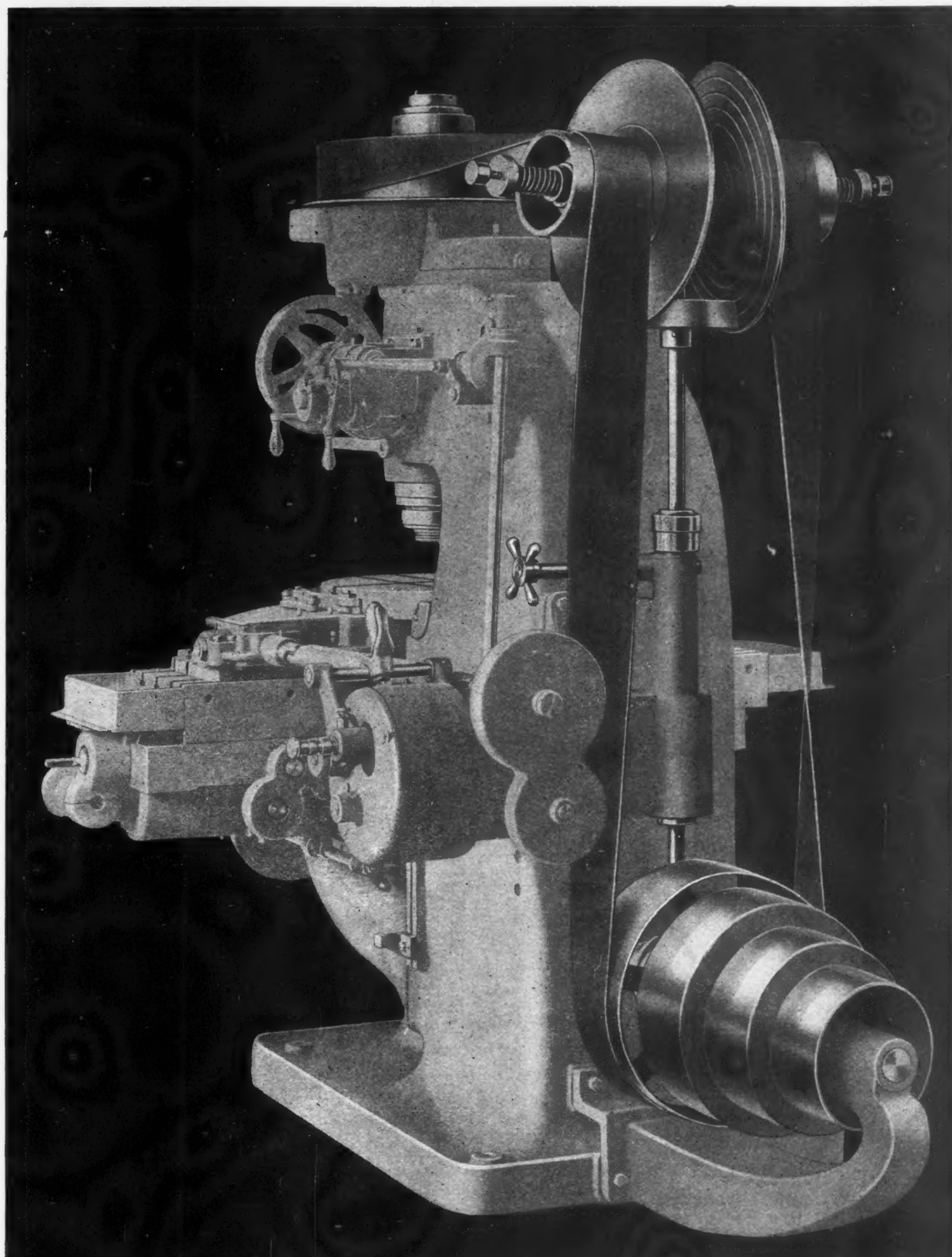
Here's A Profitable Battery of
Farwell Gear Hobbers

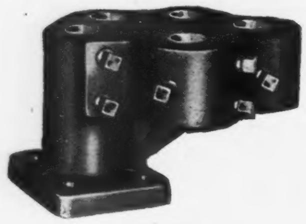
Profitable not only in the sense that they do their work well, *but that they do it with remarkable economy.* The machines are nine Farwell Gear Hobbers owned by the Stewart-Warner Speedometer Corporation, Chicago, Ill. The work is forged steel gears, average diameter 4″, ½″ face, ranging in pitch from 6 to 8, with special emphasis on accuracy and all the speed possible. Production per day of 8¾ hours averages 65 gears, each machine. The work is economically done, because a Farwell Gear Hobber never requires all of an operator's time. Once the work is set up and the cut started, the machine requires no further attention till the gear is completed. In many instances one operator looks after four busy machines.

Farwell Gear Hobbers are simple, efficient, powerful, rugged—record producers, profitable machines in every sense of the word.

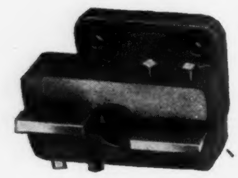
If you buy or make gears, let us tell you more about Farwell Hobbers.

THE ADAMS COMPANY, 1903 MARKET STREET DUBUQUE, IOWA, U.S.A.

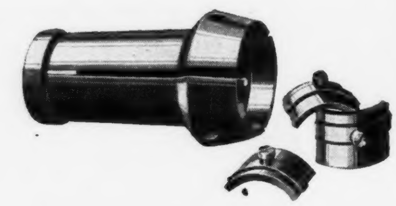




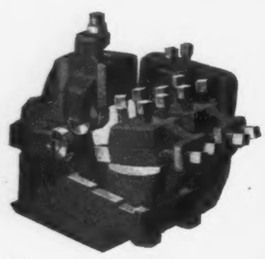
No. 107
Multiple Turning Head



No. 108
Facing Head

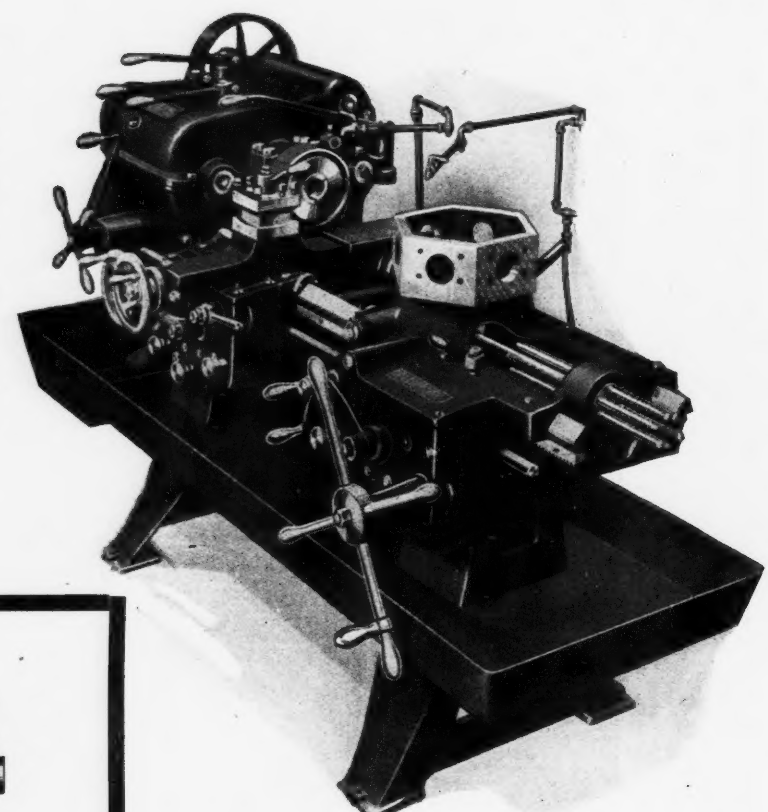


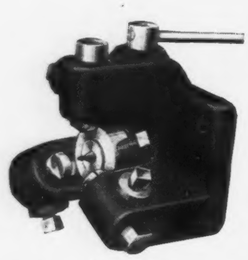
Push-Out Collet with Bushings



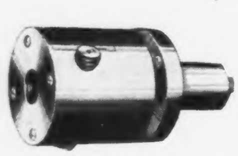
No. 139
Multiple Cutter Turner

The FOSTER 1-B Universal Turret Lathe with its tools and attachments is establishing a new and higher standard of production per dollar invested. Let us tell you more about it.

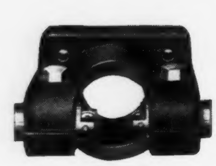




No. 142
Center Drilling Tool



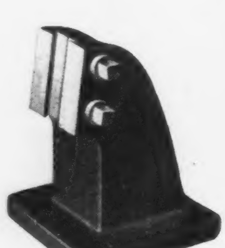
No. 120
Adjustable Drop-off Tap Holder



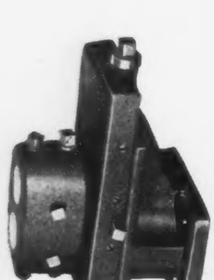
No. 143
Knurling Tool

The Foster 1-B Universal Turret Lathe

A machine that is adapted for manufacturing in large quantities as well as producing a wide variety of parts in small lots—a machine that brings to its work tremendous power, rigidity and strength. The Foster 1-B is provided wtih a complete and extensive equipment of standard tools and attachments, and with means for handling work of more or less special nature. Range includes bar and chucking work, from wide forming in steel to turning hard cast iron of large diameter. As many as twelve cutters can be mounted on the two tool carrying units; turret and cross slide can be operated simultaneously and independently with widely different feeds. A carefully devised arrangement of operating helps aids in maintaining a high rate of production.



No. 149
Rear Forming Tool Holder



No. 116
Slide Tool

FOSTER MACHINE COMPANY

ELKHART, INDIANA, U. S. A.


SCHIEREN
BELTINGS
SUCCESSFUL
INDUSTRIES
Scientific research daily shows us better ways of doing things and new uses for existing materials, gives us devices to make work easier or life more enjoyable, and creates materials to meet new conditions.
The march of progress goes on uninterrupted by wars, floods or devastation — new industries spring to life and, from humble beginnings, grow rapidly to powerful factors in the world's existence.
The use of POWER—its successful application and transmission—is a governing factor in the growth of many industries. Make the most of it in yours.

Practical Economy in Belting Application

As the user and buyer, you know first of all that **a belt** is needed to transmit so much power from motor, engine or lineshaft to a certain machine.

You have first-hand knowledge of the place it is to go into, and the conditions under which it must operate. Your specifications are final—accepted without question—because you are on the ground **and know.**

That is the initial step in the application of a belt for transmitting power.

The second step is the selection of the **proper belt** to successfully transmit the desired amount of power under your conditions.

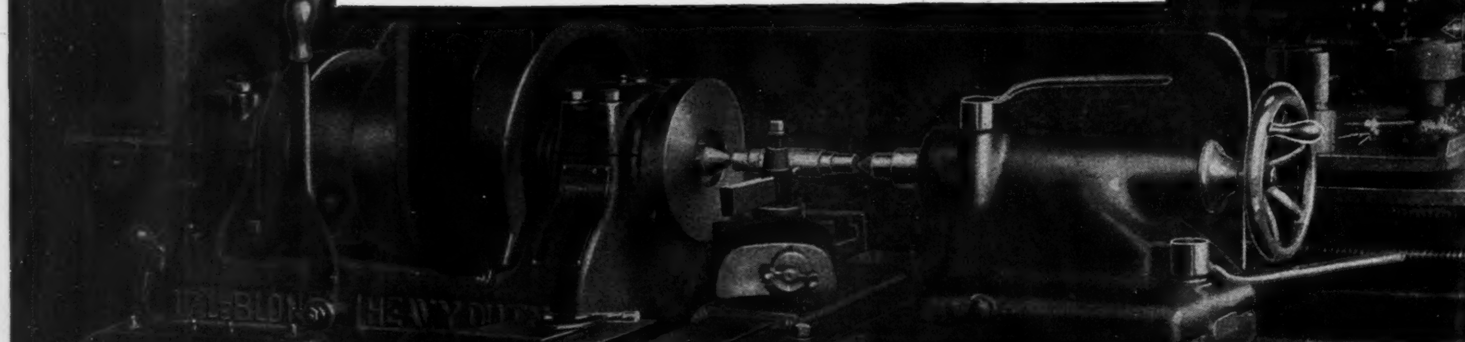
That is where **Schieren Engineering Service** comes in.

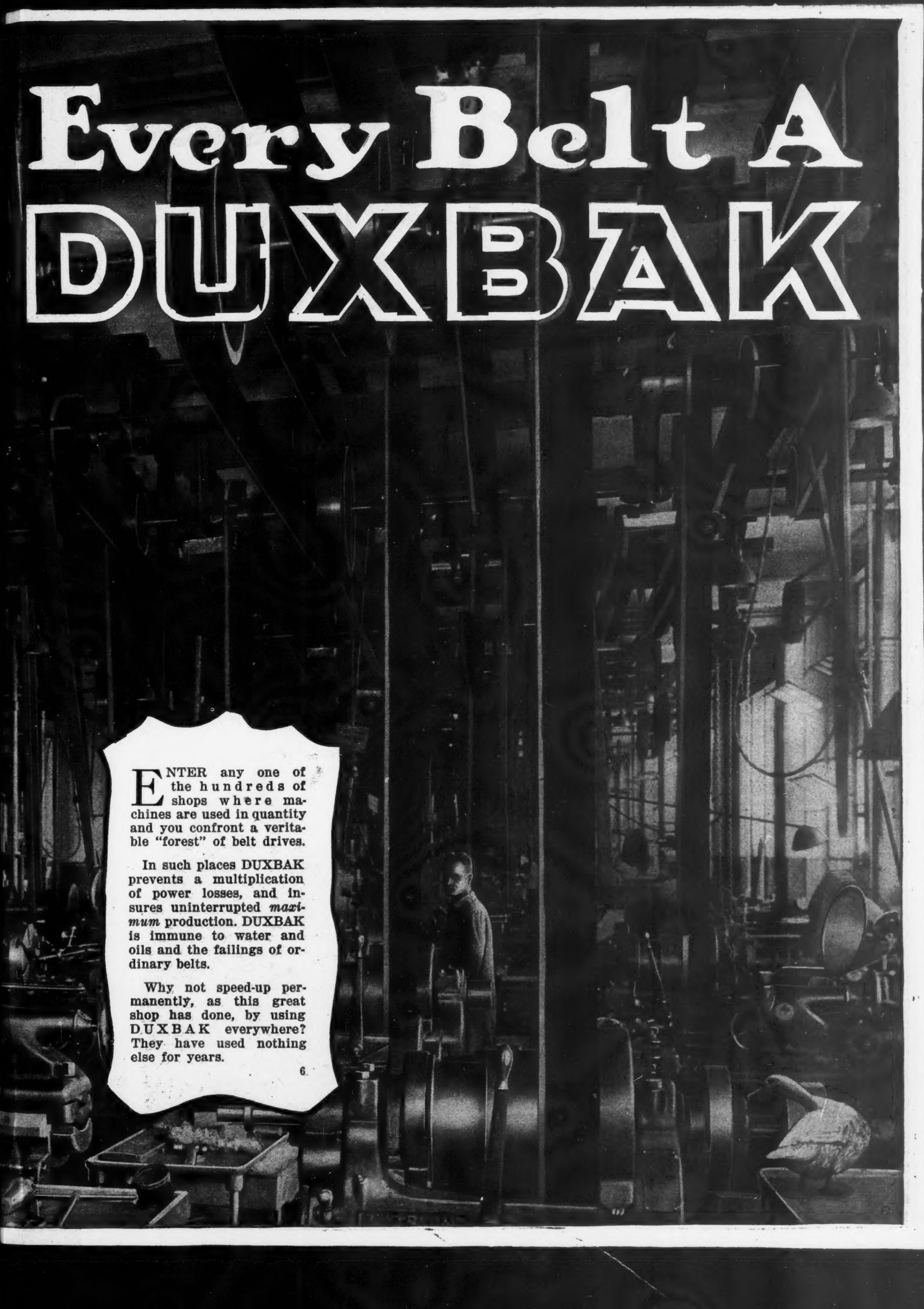
We have not been manufacturing and installing leather belts for more than fifty years without gaining a broad experience and an immense reserve knowledge of what a leather belt will do under any and all conditions.

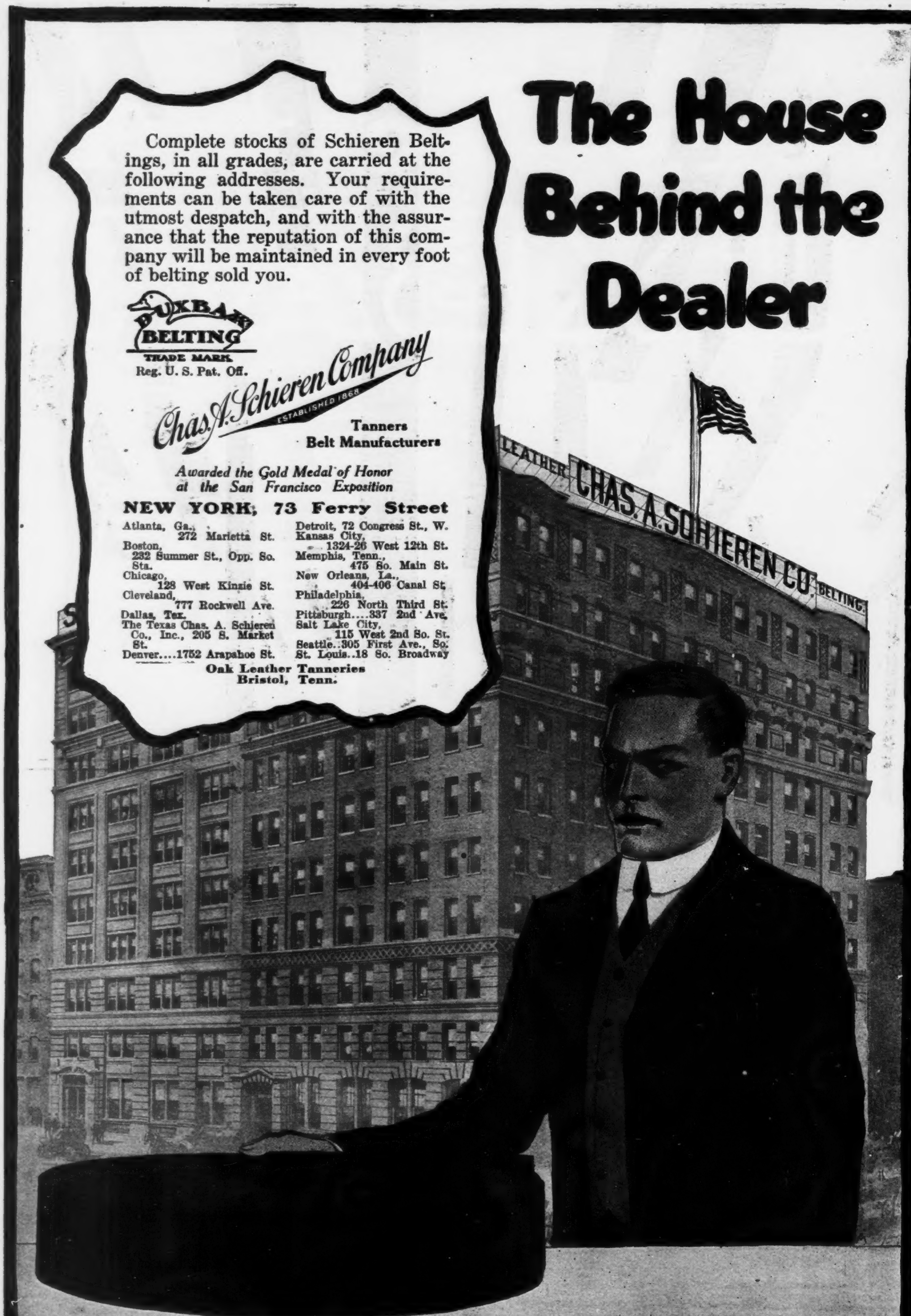
We **know** the kind as well as size of belt you should use as soon as we learn your requirements and the conditions of service.

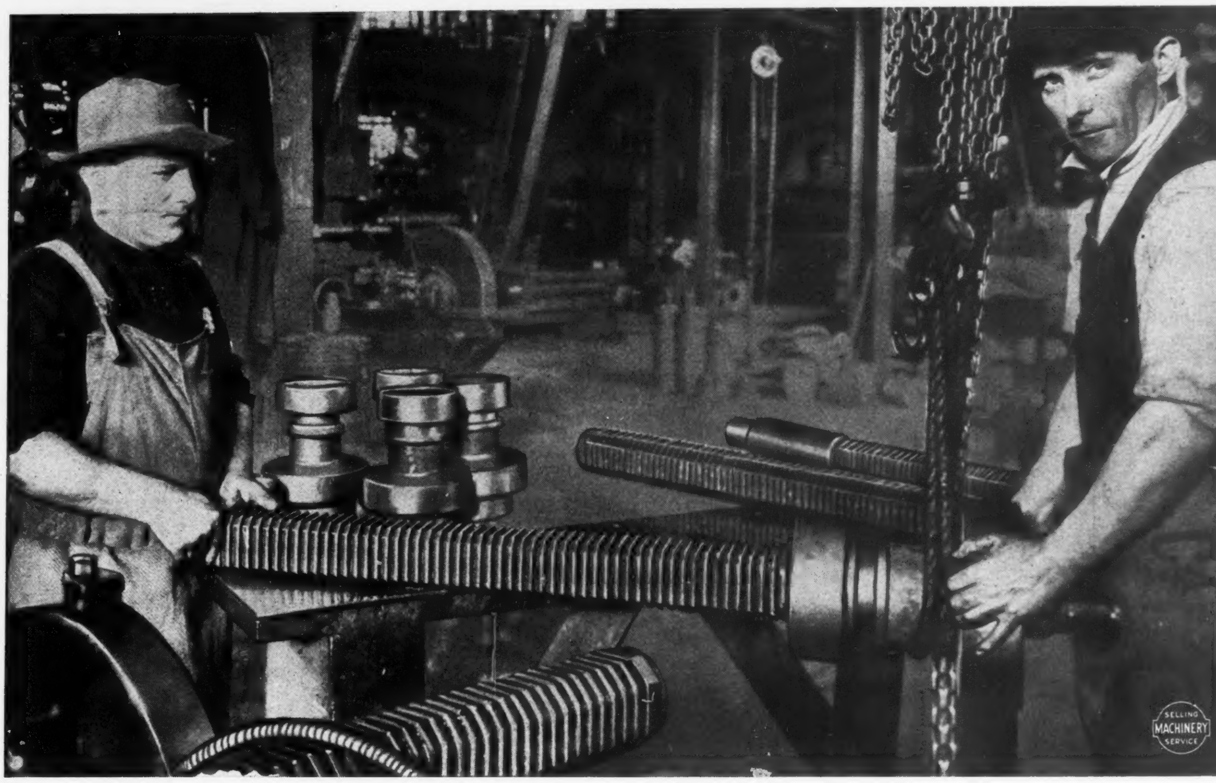
Schieren brands of belting, in all grades, have always stood for honesty in manufacture, and **Schieren Engineering Service,** based upon honesty in application, will not let you buy other than **the belt which will most economically meet your requirements.**

Half a century of experience and knowledge of belting application, as well as a definite and liberal guarantee as to material and workmanship, will be back of our recommendations on any belting requirements you trust to us, and our complete stocks at convenient centers insure prompt as well as intelligent and reliable service.




Every Belt A
DUXBAK
ENTER any one of the hundreds of shops where machines are used in quantity and you confront a veritable "forest" of belt drives.
In such places DUXBAK prevents a multiplication of power losses, and insures uninterrupted *maximum* production. DUXBAK is immune to water and oils and the failings of ordinary belts.
Why not speed-up permanently, as this great shop has done, by using DUXBAK everywhere? They have used nothing else for years.
6


The House Behind the Dealer
Complete stocks of Schieren Beltings, in all grades, are carried at the following addresses. Your requirements can be taken care of with the utmost despatch, and with the assurance that the reputation of this company will be maintained in every foot of belting sold you.
DUXBAK BELTING
TRADE MARK
Reg. U. S. Pat. Off.
Chas. A. Schieren Company
ESTABLISHED 1868
Tanners
Belt Manufacturers
Awarded the Gold Medal of Honor at the San Francisco Exposition
NEW YORK, 73 Ferry Street
Atlanta, Ga., 272 Marietta St.
Boston, 232 Summer St., Opp. So. Sta.
Chicago, 128 West Kinzie St.
Cleveland, 777 Rockwell Ave.
Dallas, Tex. The Texas Chas. A. Schieren Co., Inc., 205 S. Market St.
Denver....1752 Arapahoe St.
Detroit, 72 Congress St., W.
Kansas City, 1324-26 West 12th St.
Memphis, Tenn., 475 So. Main St.
New Orleans, La., 404-406 Canal St.
Philadelphia, 226 North Third St.
Pittsburgh....337 2nd Ave.
Salt Lake City, 115 West 2nd So. St.
Seattle..305 First Ave., So.
St. Louis..18 So. Broadway
Oak Leather Tanneries
Bristol, Tenn.
LEATHER
CHAS. A. SCHIEREN CO.
BELTING



THE broaching machine made by the J. N. Lapointe Co. scores again. At the J. I. Case Threshing Machine Company's plant, this time, broaching the bearings in transmission gears for 40 H.P. gas tractors. The gear is forged steel; bearing is 3" square by 12" long. Four broaches are required, 15 minutes complete the job. The official "communique" is "most satisfactory; profitable commercially."

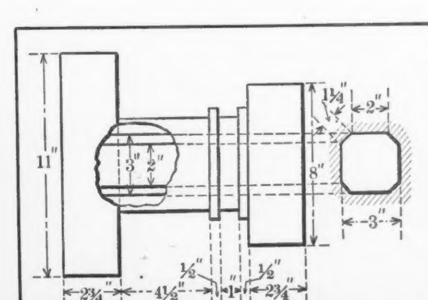
The fact that we have not only the name but the man himself, Mr. J. N. Lapointe originator of the Lapointe Broaching System, is a sufficient guarantee of the quality of our product.

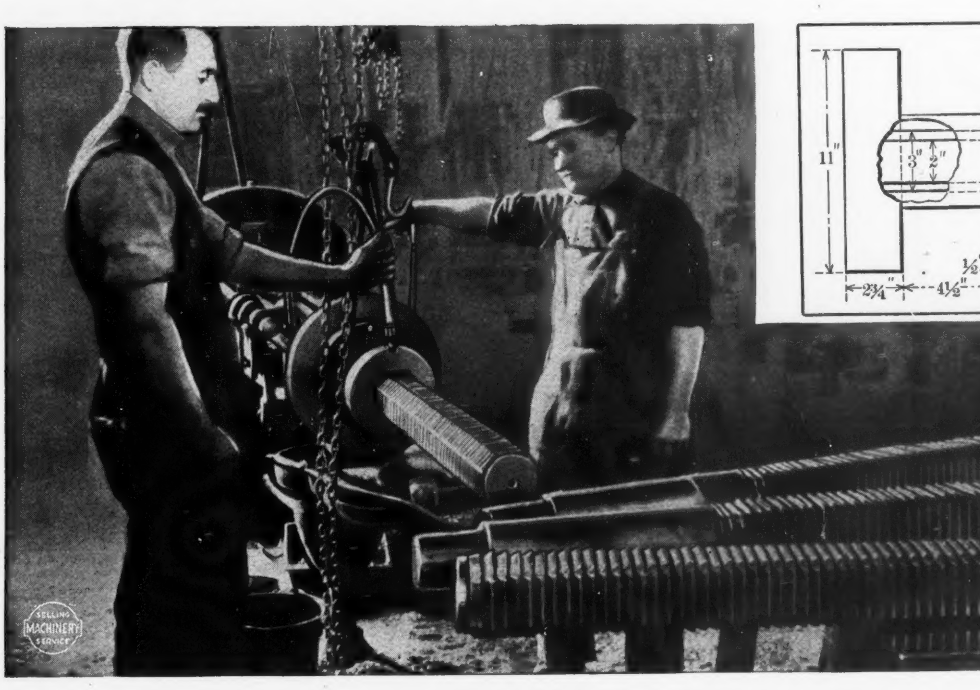
THE J. N. LAPOINTE COMPANY

NEW LONDON - - CONN., U. S. A.

Broaching Large Holes Profitably

Send blue prints, samples or sketches of your work

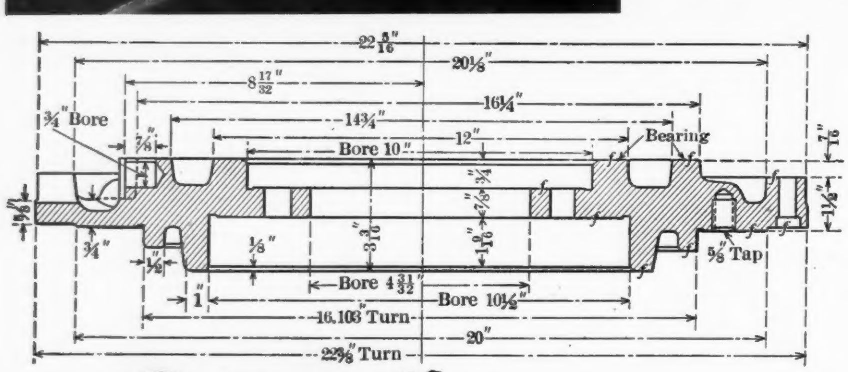




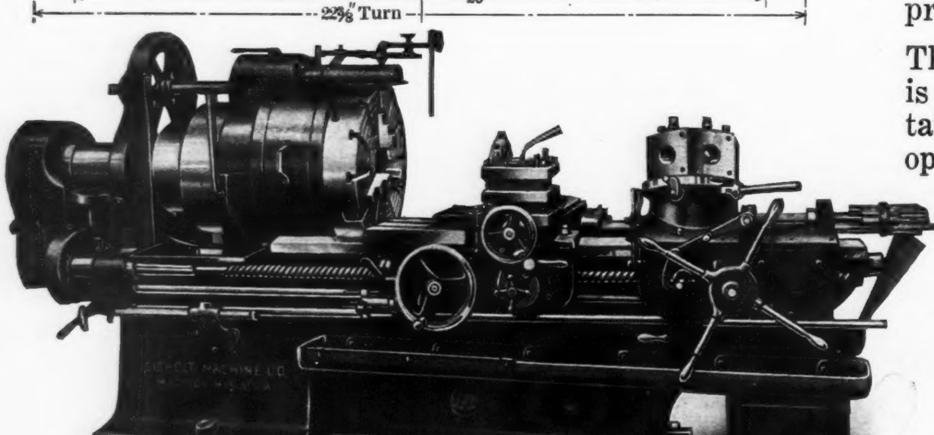
Lowering Costs with a Gisholt Turret Lathe

The use of tool post and turret simultaneously is one of the means offered for lowering costs with the Gisholt Turret Lathe. The photographs herewith and the accompanying sketch illustrate this Gisholt practice. The machine is a standard 34″ Gisholt Turret Lathe equipped with standard tools for finishing the piece shown in the line drawing as indicated by finish marks. The piece is the back plate for a 24″ scroll chuck. It is of cast iron and must be finished within very close limits.

The tool post and turret are used simultaneously on this work, which makes possible the low production time of 19 minutes each for finishing the surfaces indicated. The time of 19 minutes covers the operation illustrated.



And these parts, when completed, are virtually self-assembling, and this, we claim, is the test of true efficiency in a machine tool. The Gisholt Turret Lathe has been simplified and perfected to such a degree that it produces finished parts so close to the required standard that hand-work is practically eliminated.



The Gisholt Engineering Staff is at your service. It is maintained for the purpose of cooperating with manufacturers in an effort to reduce machining costs. We'll be glad to have you make use of it.

The "Gisholt way" is the economical way—try it.

GISHOLT

GISHOLT MACHINE COMPANY,

50 CHURCH STREET,

How Much Does It Cost per Year to Grind Your Tools

Never figured it out? It is a bigger item than you would think it could be—we can tell you that much without even knowing how many tools you grind.

Your machinists grind their own tools—every minute they are away from their machines is just so much time the machines are standing idle; every minute a man stands waiting to get at the grinder is just so much of his time wasted. And this waste, this unproductive time, costs many dollars per man each year. It totals an almost unbelievable amount in a big shop.

The Gisholt Universal Tool Grinder does away with this waste. It provides a correct mechanical means for grinding turret lathe, engine lathe, shaper, planer, boring mill and slotter tools—*each tool at its correct cutting angles.* It duplicates its work always. It establishes a standard of correct grinding angles. It keeps machine operators at their posts—eliminates this source of time waste by exchanging correctly ground tools for dull ones as fast as they are needed. There are other advantages; but the principal one is the savings this grinder accomplishes.

Dodge Bros. find it pays to use several Gisholt Tool Grinders; the photograph shows thousands of toolpost tools which have been reclaimed and, properly ground, are ready to be started through the shops again.

This machine gives you many advantages—

—does away with idle machines and non-productive work by machinists;

—stops dull and unused tools from lying around machines;

—cuts down your tool-steel investment by enabling you to get along with fewer tools;

—stops loss of valuable tools;

—gives you the increased production that comes from correctly ground tools;

—gives you the saving that comes from re-forging tools in lots instead of singly;

—gives you general orderliness, the value of which cannot be overestimated.

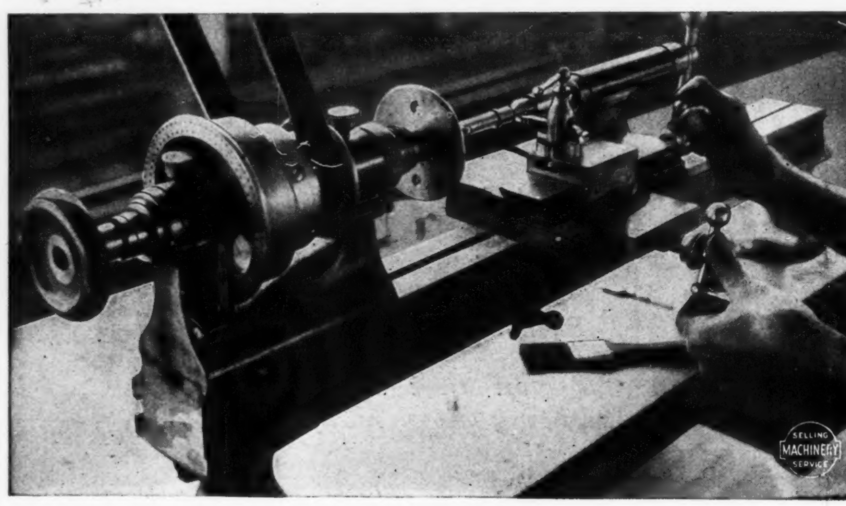
No need to train anyone especially for the work. A boy can learn to operate it properly in a few hours.

1208 E. Washington Ave., Madison, Wis.

NEW YORK CITY

AMES BENCH LATHES

Are All-Around Machines



Ames Lathes are designed and built for precision manufacturing and tool room work. They are carefully put together, rapid, easy to handle and dependable in action no matter how exacting the work. Provided with turret, milling, grinding, drilling, filing and thread cutting attachments, there's practically no limit to Ames usefulness.

Before you decide on bench lathe equipment ask us more about Ames Advantages.

B. C. AMES COMPANY - Waltham, Mass.

LEVER QUICKER THAN SCREW CONTROL

The lever at the center of the apron instantly controls both feeds—whereas a star wheel or knurled knob operates but gradually, and that with difficulty, when the machine is running at a high rate of speed.

With lever control the operator can use power feed right up to the shoulders. This is a distinct time saver and a characteristic feature of

MORRIS LATHES

Morris Lathes, 16, 18 and 22 inches, are made with single and double sliding back gears, special patented apron and four changes of positive feed. Complete specifications on request.

We also make 2½, 3 and 3½ foot Radial Drills.

THE MORRIS MACHINE TOOL COMPANY

CINCINNATI — ENGLISH AGENTS: A. A. Jones & Shipman, Ltd., Leicester, England — OHIO, U. S. A.

Building the Universal Reputation

A Series of "Cold Fact" Advertisements of which this is No. 11

"Where Accuracy Counts, We Win"

The casting is mounted on a special boring fixture clamped to the machine table, boring all being done through the two bushed holes shown. The fixture has bushed support in the rear as well as front to facilitate operation and permit the use of the machine without rear support.

Rigidity, convenience, accuracy, durability—five years failed to develop a single weakness anywhere. Why not enjoy records like this, too?

Same Machine Same Work Same Accuracy for the past Five Years

In the plant of the Continental Motor Company, Allentown, Pa., these three Universal Horizontal Boring Machines may be seen handling the same work they were doing five years ago, all showing the same degree of accuracy and high rate of production that characterized their operation then.

The work is on aluminum engine cases for Mack trucks—boring and facing three crank case bearings, three camshaft bearings and drilling two idler gear bearings.

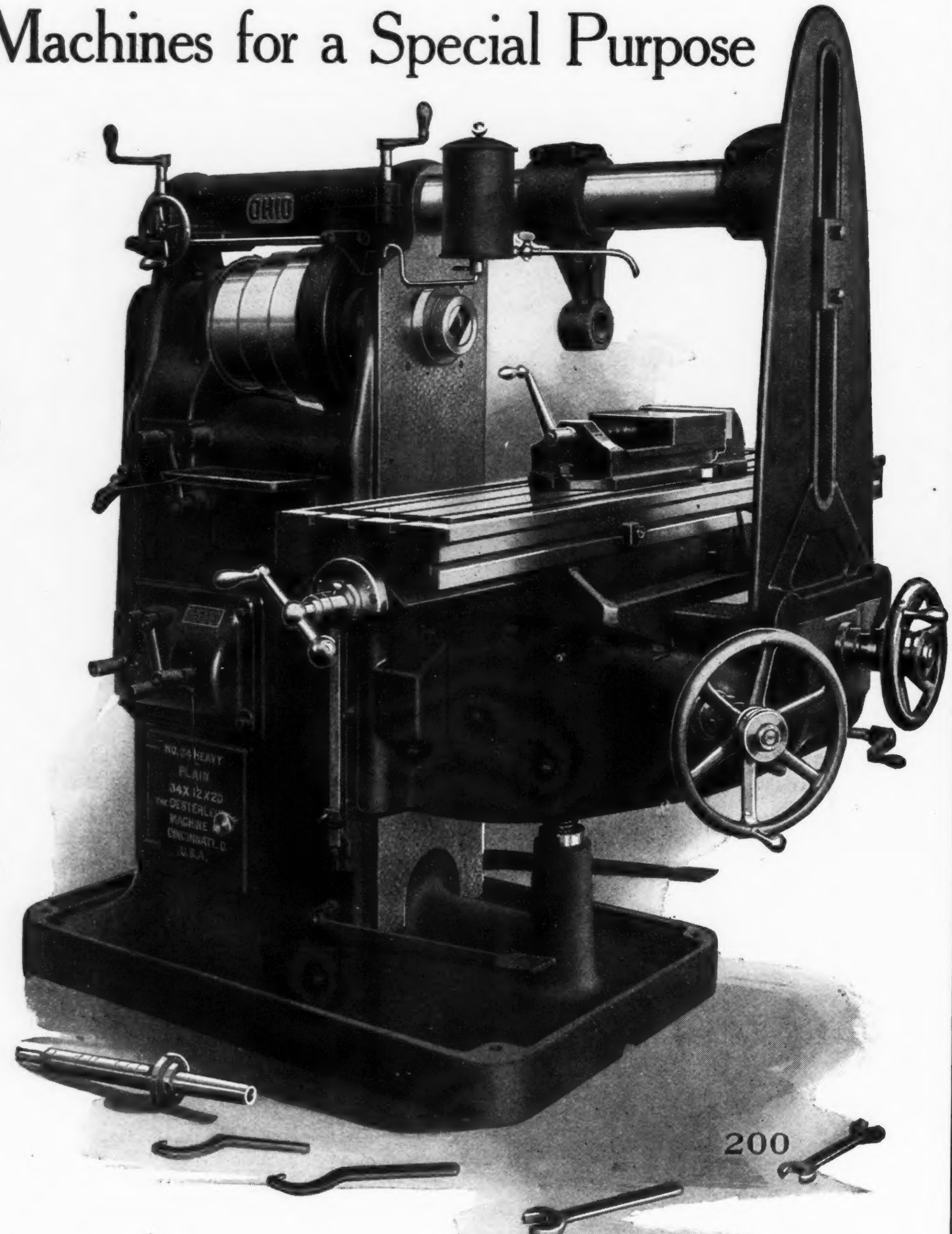
Catalogue on request

UNIVERSAL BORING MACHINE COMPANY

HUDSON MASSACHUSETTS, U. S. A.

OHIO MILLERS

Machines for a Special Purpose



OHIO
Millers

OHIO
Grinders

WE have spent years of time and barrels of money in developing Ohio Millers for one special purpose—the low cost manufacture of such work as comes within the range of a knee type milling machine.

Ohio Millers possess the capacity, the structural power, the speed, convenience and accuracy necessary for maximum outputs at minimum costs. If you manufacture you can't find better machines. Let us tell you more about them.

The Oesterlein Machine Company

Cincinnati
Ohio, U. S. A.


NATIONAL
THE NATION PREPARED
NATIONAL
Twist Drills and
Tools play no
small part in
this gigantic
undertaking
NATIONAL TWIST DRILL
& TOOL CO.
Detroit · Mich.
NATIONAL TWIST DRILL & TOOL CO.
NEW YORK OFFICE
50 CHURCH ST.
CHICAGO OFFICE
104-106 SOUTH JEFFERSON ST.

Foote-Burt High Duty Drills

Machines you are Going to Need

Write for the Bulletin before you order drilling equipment

With all the forces of the United States organized for offense and defense, American manufacturers are facing the busiest and most important period of industrial history. Their prime need is machines—good machines, machines built like the Foote-Burt No. 25 High Duty 24″ Drilling Machine.

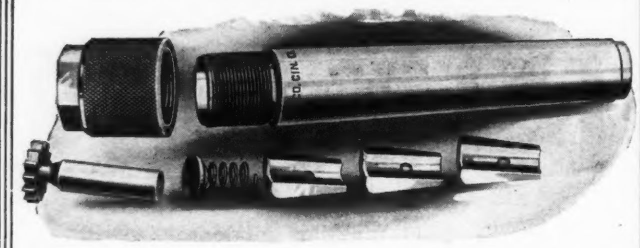
The No. 25 is as rigid as a machine can be made, modern to the smallest detail, and drives high speed drills, up to 3″ size, to full cutting edge capacity. All speed and feed changes are made through quick change gear device of special design; spindle is of forged high carbon steel, fitted with ball bearing thrust of our own design, *guaranteed not to crush under the severest duty.* All levers are within easy reach. Briefly, the function of this machine is to work hard and keep at it.

THE FOOTE-BURT CO., Cleveland, Ohio

MILWAUKEE OFFICE, 424 Wells Building.

DETROIT OFFICE, 806-8 David Whitney Building.

FOREIGN AGENTS: Buck & Hickman Ltd., London, Birmingham, Manchester and Glasgow. Moscow Tool & Engine Co., Moscow, Ing. Ercole Vaghi, Milan. R. S. Stokvis & Zonen, Ltd., Rotterdam. R. S. Stokvis & Fils, Brussels. Glaenzer & Perreaud, Paris, agents for France, Switzerland, Spain and Portugal. Benson Bros., Ltd., Sydney, Australia, agents for Australia and New Zealand. Mitsui & Co., agents for Japan, Korea and Manchuria. Wilh. Sonesson & Co., Ltd., Malmo, Sweden and Copenhagen, Denmark.



How Do You Hold Your Woodruff Keyseat Cutters and Other Tools with ½″ Straight Shanks?

LOOK

This chuck is made with a taper shank either B & S or Morse to fit the spindle of your machine. The design is such that the jaws do not fall together, but allow free entrance of the shank at all times.

Send for our catalogue and get acquainted with our tools.

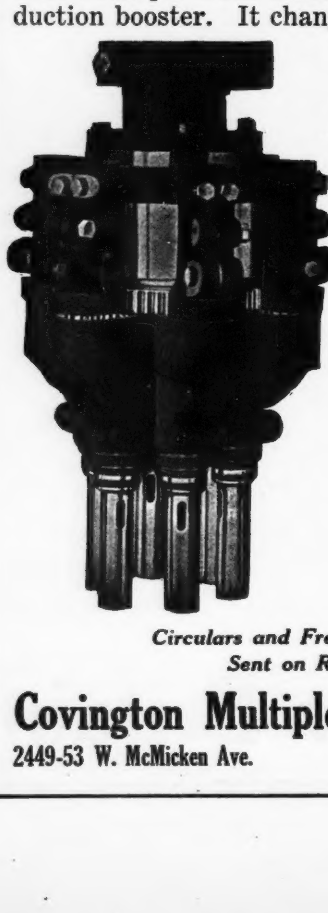
THE ADVANCE TOOL CO.

Canal & Jackson Sts., Cincinnati, Ohio

Agents wanted in all principal cities

With the Covington, Eight Holes Cost No More than One

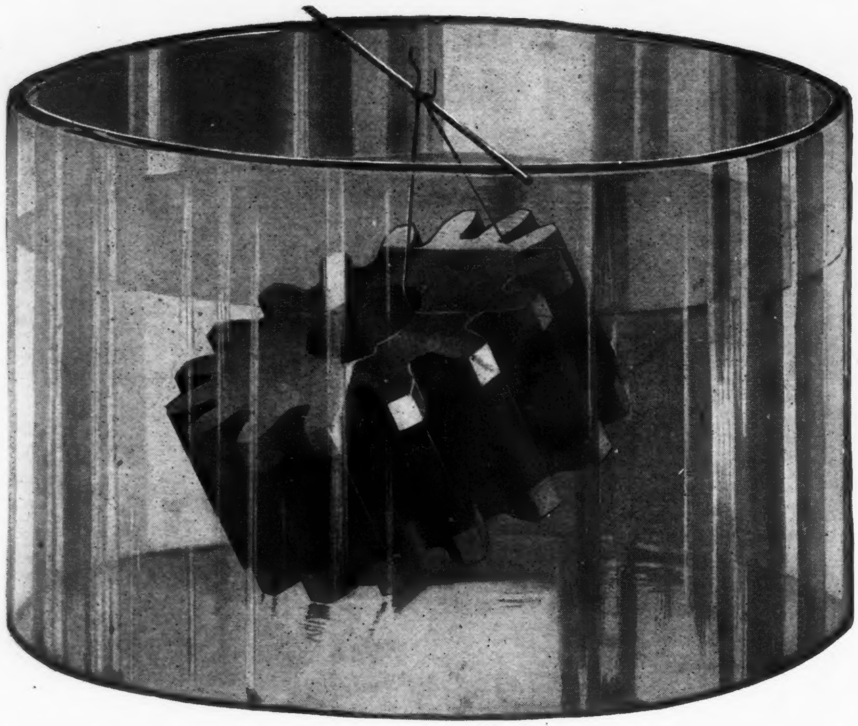
This Multiple Drill Head is a "sure fire" production booster. It changes single drill output to multiple in a minute's time and with practically no additional expense. The head, furnished with from 2 to 8 spindles, can be easily adjusted to any upright drill press from 20″ to 36″ in size, or to large radials, and each spindle "stays put" after adjustment. The Covington is sturdily built throughout, handles a great variety of drilling, gives lasting service.



Circulars and Free Trial Offer Sent on Request

Covington Multiple Drill Company

2449-53 W. McMicken Ave. CINCINNATI, OHIO



Why Tie up an Engine Lathe on Plain Turning?

The other job is turning rough cast iron generator gears, 3.526″ diameter, mounted 12 on an arbor. About 1/16″ stock is taken off; limit is within 0.001″ of standard size. When the blanks are finished the operator takes them, arbor and all, over to the two gear cutting machines that cut the teeth. He keeps them going in addition to his P-C Lathe and is by no means overworked.

Porter-Cable Manufacturing Lathes are practical, hard-working machines. They take big cuts, turn big chips, insure big output. They save money on work not over 9″ diameter by 18″ long, and are ideal for duplicating parts in quantity.

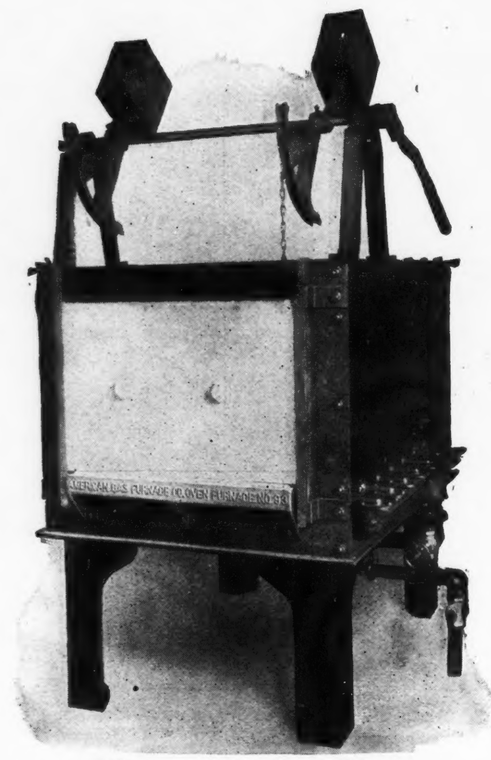
We'll be glad to go over P-C advantages in detail and tell specifically what our machines are doing for others. Write us.

The P-C Manufacturing Lathe

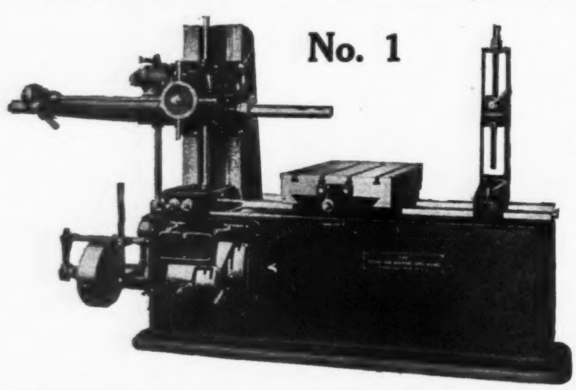
Just as fast, just as efficient and immeasurably more economical is the Porter-Cable Manufacturing Lathe. Here are two P-C Lathes at the Stromberg-Carlson Telephone Manufacturing Company's plant, Rochester, N. Y. One is turning armatures; (92 punched steel blanks) the cut is intermittent; the diameter must be 1.480″, held with a 0.001″ limit. The operator starts the cut across the armature at a speed of 140 r. p. m. and a feed of 0.040″ per revolution, and goes right on filing armatures that have already been turned. All he does to the machine is take off finished work and start new work.

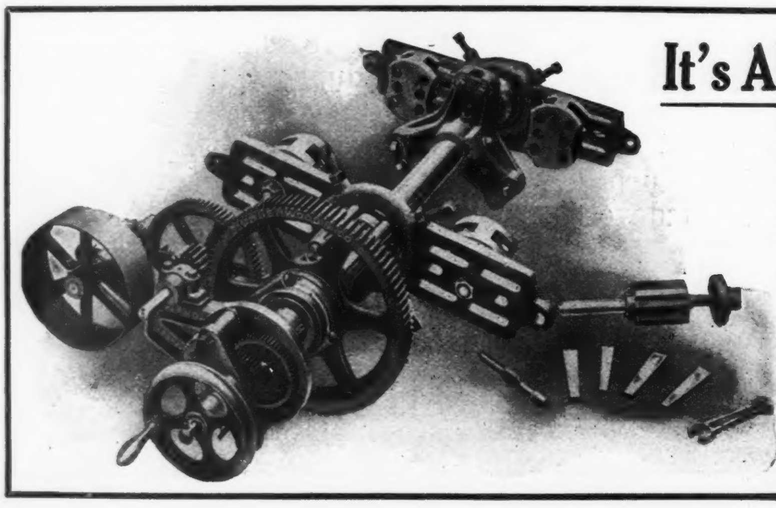
The Porter-Cable Machine Co.
SYRACUSE N.Y., U. S. A.

Foreign Representative: Benjamin Whittaker, 2 Norfolk Street, Strand, London

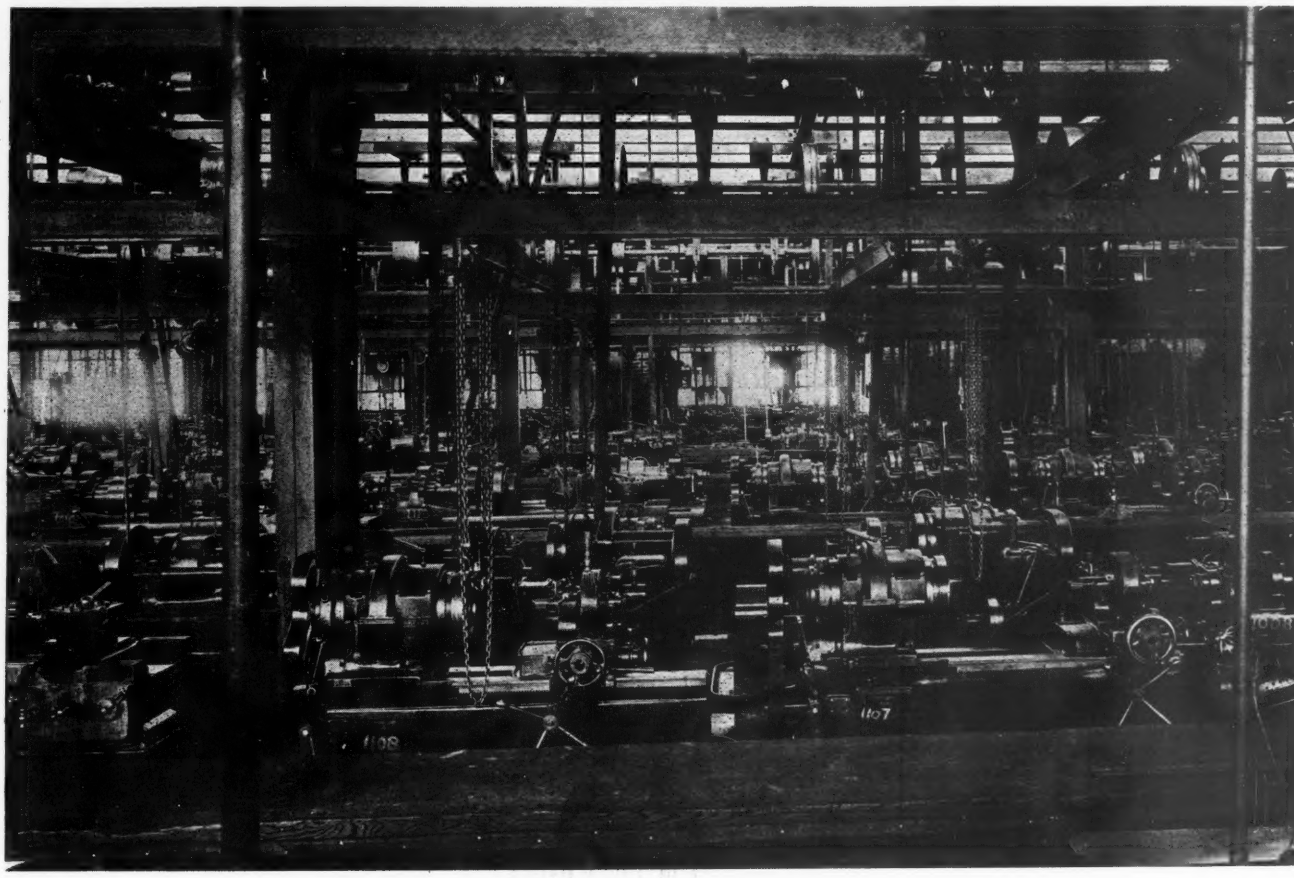


Made in Various Sizes





LEES-BRADNER
COLLET TYPE THREAD MILLERS



Collet Type Thread Millers in One Plant
facturers; Approximately 1000 in Operation

threads with a hob type cutter in one revolution of the work. The work is supported in a positive opening and closing Collet. Remarkable accuracy and production are obtained. Built in sizes up to 9½-inch Collet capacity. Send us blue prints of the work under consideration.

THE LEES-BRADNER COMPANY

CLEVELAND, U. S. A.

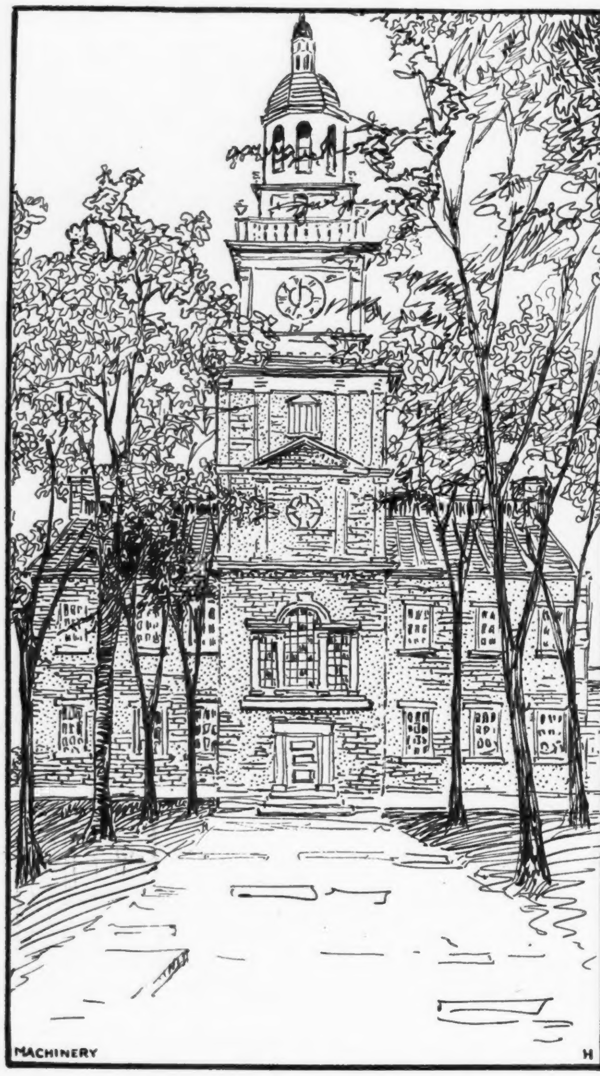
THREAD MILLERS GEAR GENERATORS

Two Stories *of* American Independence

ONE is the story of National Independence and goes back to 1776 when the Signers of the Declaration proclaimed America free.

The other has to do with industrial independence—the freeing of American manufacturers from the handicap of uncertain supplies. The new country needed steel products of the highest grade. Hermann Boker & Company did their part to establish and maintain an adequate and accessible supply of the world's best steel specialties on American shores.

Right now we are pushing Gibraltar—"The Tool Steel without a risk." We recommend it, without qualification, for threading dies, taps, chasers, punches and dies, reamers, milling cutters, form cutters and other uses where high speed steels are unsatisfactory. We stake our reputation upon Gibraltar Tool Steel. In the 80 years of our experience we've never seen anything better. Try it. Ask for the booklet.



Independence Hall

NOVO SUPERIOR
The Steel without an equal.

NOVO
The standard in high-speed steel.

INTRA
The non-shrinking tungsten alloy tool steel.

GIBRALTAR
The tool steel without a risk.

H. BOKER & COMPANY, Incorporated

Successors to HERMANN BOKER & COMPANY

101 DUANE STREET NEW YORK, N. Y.

CLEVELAND CHICAGO MONTREAL PHILADELPHIA BOSTON

ESTABLISHED 1837


The airplane has reached a point in its development where it becomes, in the opinions of men who should know, the greatest single factor in the greatest war ever fought. It is confidently expected to prove the deciding factor. It is already known as the "Eyes of the Army" without which that army is almost helpless.
GREENFIELD
MACHINERY

REG. U. S. PAT. OFF.

GTD

It is easy to moralize—to draw a lesson from this event or that—after it is all over. One lesson we learned quickly from the world war, however—the absolute necessity for accuracy in manufacture. It got to the manufacturers in this country fast. It was an expensive lesson to some—a lesson that once learned will never be forgotten.

First machinery, then shells, now ordnance and airplanes—where would we be without means and methods for duplicate manufacture?

The making of precision tools and measuring instruments is a fine art. G. T. D. Screw Cutting Tools and G. T. D. Standard Gages for both screw thread and cylindrical work have been developed to a high point of efficiency. They have helped many munitions and ordnance makers over the rough spots. They can help you. They can save money for you. They are invaluable if you make duplicate mechanical parts.

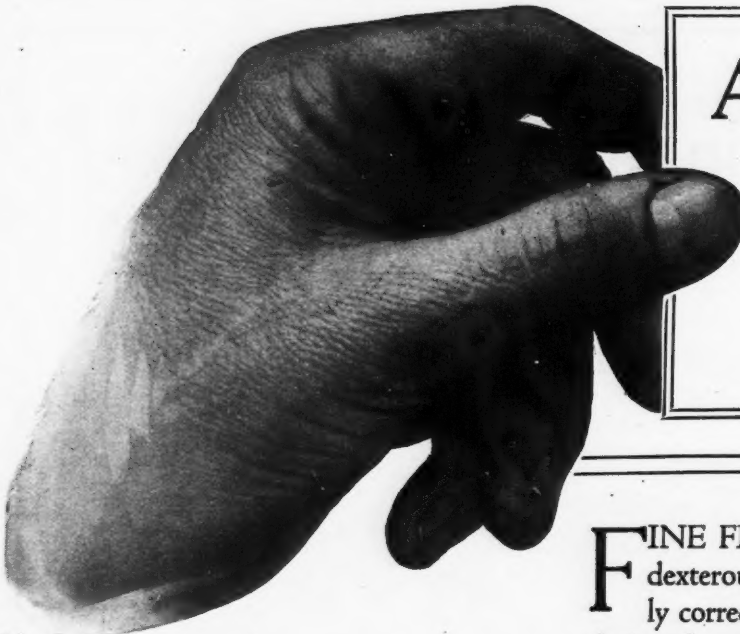
Let us send more information on this subject.

DIE CORPORATION

MASS., U. S. A.

DIVISIONS: Wells Bros. Company, Wiley & Russell Mfg. Co. A. J. Smart Mfg. Co. F. E. Wells & Son Co. Nutter & Barnes Co. Canadian Factory: Wells Bros. of Canada, Ltd., Galt, Ont.

Courtesy of Pesacola Board of Trade



AMERICAN SWISS FILES

FILES ONLY THE BEST ARE GOOD ENOUGH TOOLS
TRADE MARK

FINE FILING not only requires special skill and a dexterous touch, but calls for files that are absolutely correct in shape and cut. American Swiss Files designed especially for the finer classes of work, give unqualified satisfaction and can be duplicated accurately,

There are now more American Swiss Files in use than at any time since they were first marketed.

Specify "American Swiss"

Quality Files
for
Quality Work

AMERICAN SWISS FILE & TOOL COMPANY
24 JOHN STREET NEW YORK, U. S. A.

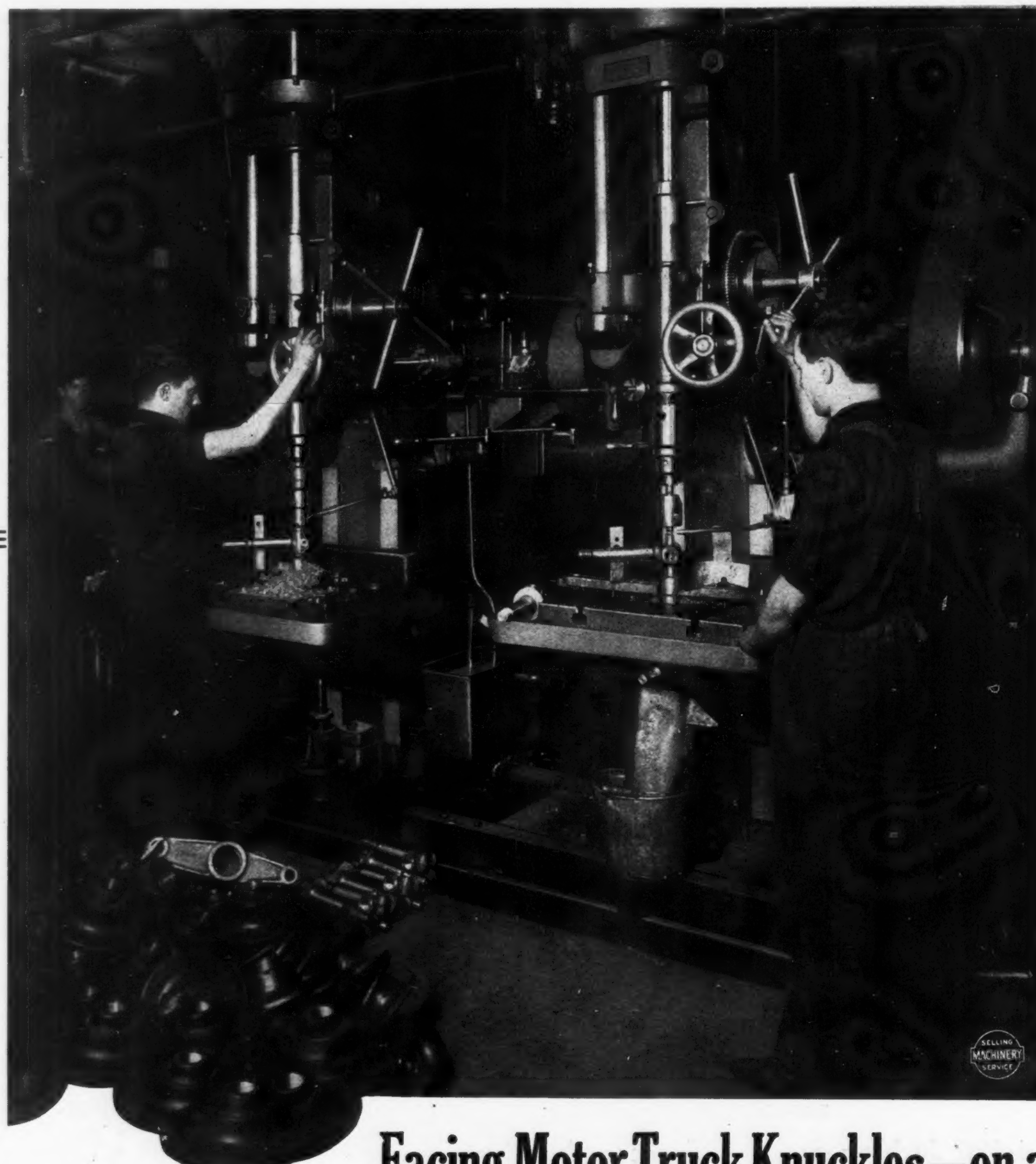
Quick Delivery Quality Tools

Large stock High Speed Steel and Carbon Steel Twist Drills, No. 60 to 3". High Speed Milling Cutters to specifications—ten days' delivery.

Tool Steel, Taps, Reamers, Tool Bits, Hack Saw Blades, Files, etc., also.

Write for Quotations

RELIANCE
STEEL & TOOL
COMPANY INC
30 Church Street, NEW YORK

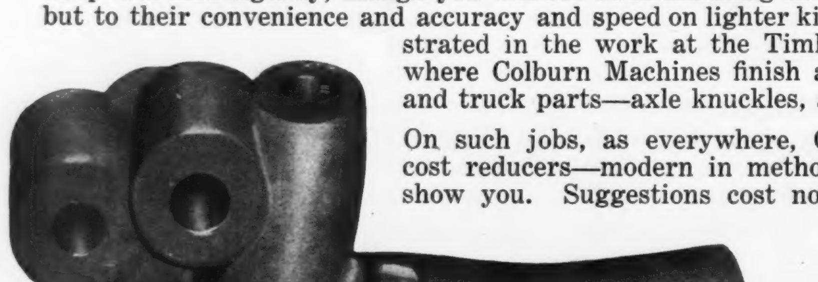


Facing Motor Truck Knuckles—on a

COLBURN DRILL

The success of Colburn Heavy Duty Drilling Machines is due not alone to their wonderful power and rigidity, though you will see them handling the heaviest work everywhere; but to their convenience and accuracy and speed on lighter kinds of work. This is demonstrated in the work at the Timken-Detroit Axle Company, where Colburn Machines finish a wide range of automobile and truck parts—axle knuckles, axles, etc.

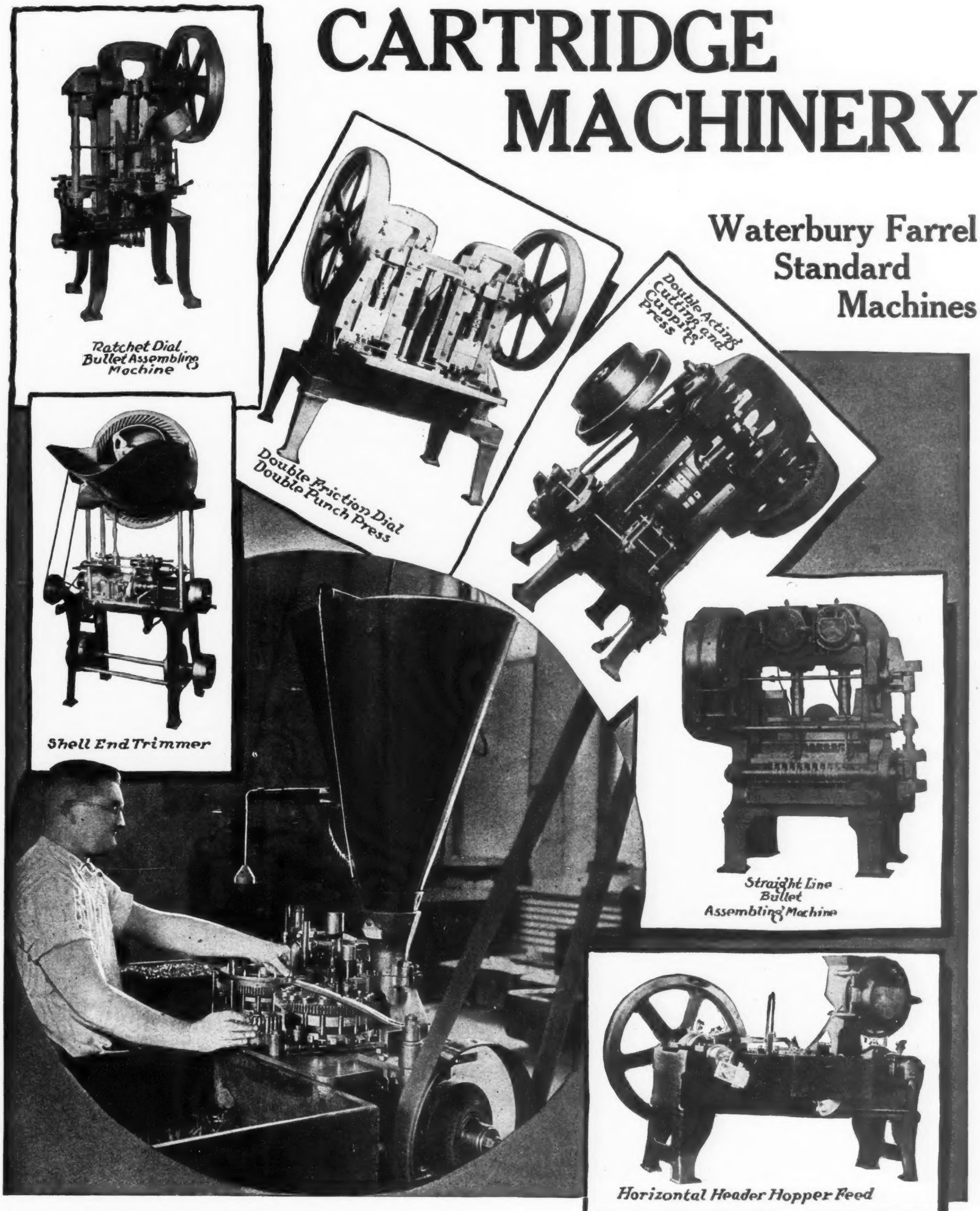
On such jobs, as everywhere, Colburn Machines are real cost reducers—modern in methods and economies. Let us show you. Suggestions cost nothing. Tell us what your problems are and we'll do the rest.



COLBURN MACHINE TOOL CO.
Franklin, Pa., U.S.A.

CARTRIDGE MACHINERY

Waterbury Farrel Standard Machines

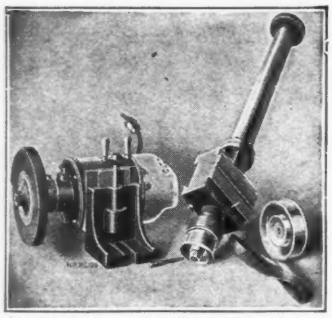


Standard Loading Machine in Government Arsenal

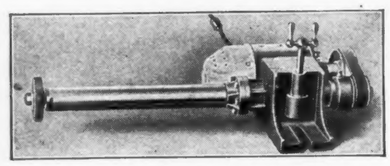
The Waterbury Farrel Foundry & Machine Co., of Waterbury, Conn., U. S. A., has appointed me to be the sole manufacturer for export of their entire line of Cartridge and Shot Shell-Making Machinery. Proposals and Estimates covering complete plants or separate units required for export will be furnished on request.

FREDERICK S. BLACKALL

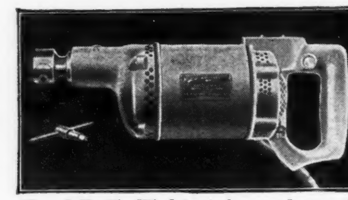
WOOLWORTH TOWER NEW YORK, U. S. A.



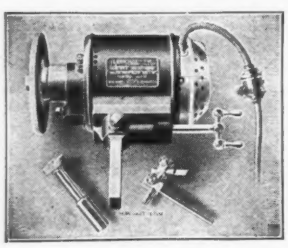
Combination Grinder with extension removed and Angle Plate fitted for external work



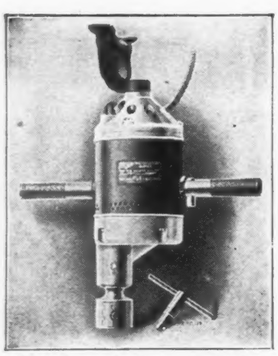
Combination Internal and External Grinder. Two sizes, ¼ and ½ H.P.



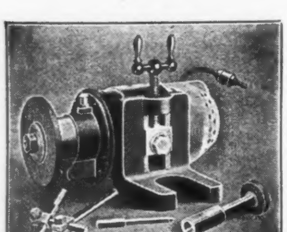
Hand Drill. Eight styles and speeds



Tool Post Grinder. Ten styles and sizes



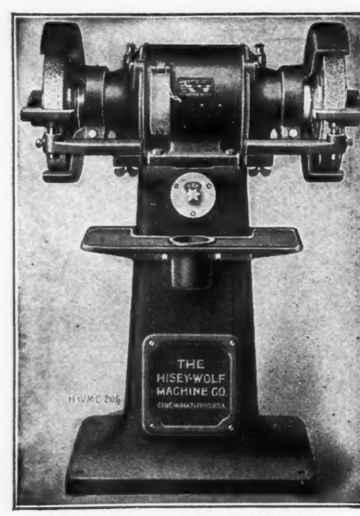
Hand and Breast Drill. Twelve styles and sizes, ¼- to ½-inch capacity



Angle Plate Grinder. Five sizes, ¼ to 3 H.P.

HISEY

Electric Machine Tools



Ball Bearing Floor Grinder. Five sizes, ½ to 5 H.P.

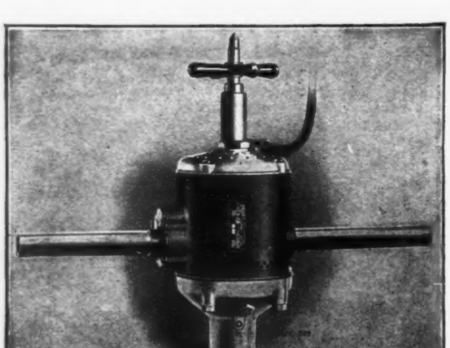
Most Complete Line of Hand and Breast Drills, Radial Drills, Sensitive Bench Drills, Portable Hand Grinders, Buffers, Bench and Pedestal Grinders, Beveling and Glass Blocking Machines.

Complete catalog No. 12 on request.

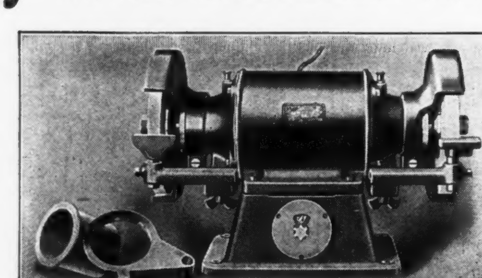
The Hisey-Wolf Machine Co.

CINCINNATI, OHIO, U.S.A.

New York Office: 50 Church Street



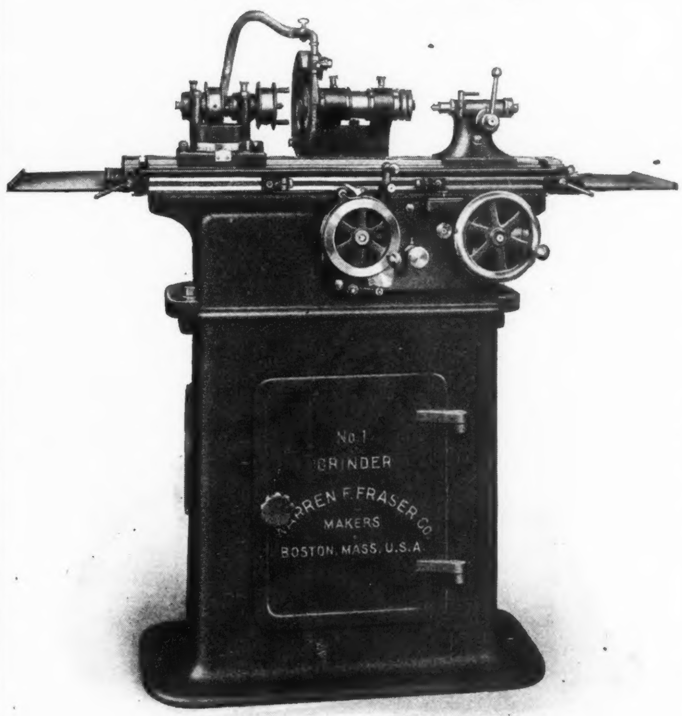
Heavy Duty Drill. Seven sizes, ½- to 2½-inch capacity



Ball Bearing Bench Grinder. Four sizes, ½ to 3 H.P.

FRASER UNIVERSAL GRINDER

The Logical Machine for Varied Grinding



No other similar machine offers greater speed and all-round convenience in changing from one set-up to another than the "Fraser." It's only a matter of a few minutes, after finishing an internal grinding operation, for instance, to make ready for either cylindrical or surface work.

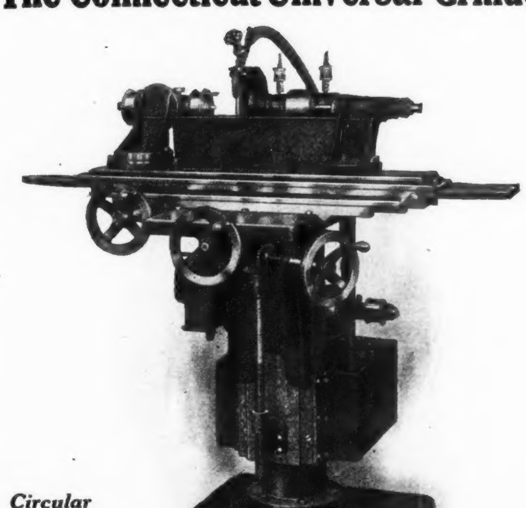
For internal grinding, capacity is 8″ outside diameter, for cylindrical grinding 8″ diameter by 20″ length, for surface grinding work up to 6″ in width and 20″ long.

Some of the more striking features of design are: Variable table movement as low as 5/8″, large bearings, double end wheel taking spindle for wheels up to 1/2″ face and 8″ diameter, box type base, three point suspension for upper part of machine, unit construction of apron permitting feed mechanism to be removed as a unit, two wheel speeds, four table speeds, five work rotation speeds. Let us tell you all about the possibilities of the "Fraser" for fine grinding on tools, gauges, jigs and fixtures as well as for production work within its range.

Detailed description on request.

THE WARREN F. FRASER CO.
Freeport Street BOSTON, MASS.

The Connecticut Universal Grinder



Circular for Complete Details

EXTERNAL, internal, surface and cutter grinding can be handled on this machine with remarkable ease and adaptability. The unique column construction allows the table to swing in a complete circle, and with the head fastened to the column, any position is available without twisting the belt. The Universal Headstock is fitted with draw-back attachment to receive special collets for grinding small cylinders—a valuable feature for tool room work.

Middlesex Machine Works
MIDDLETOWN CONN., U. S. A.

PRODUCTION

SURFACE GRINDER

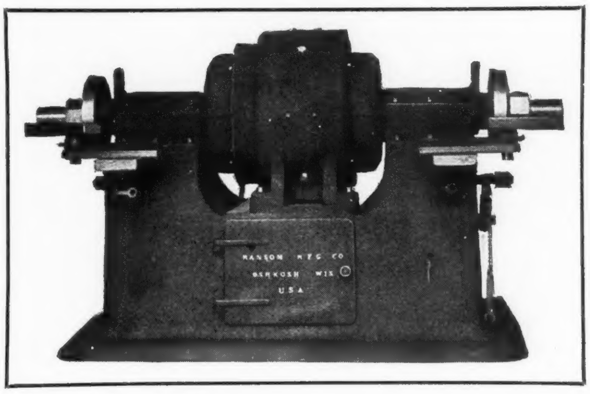
Adjustable Taper Spindle
All Surfaces Hand Scraped
Graduated Feeds

Surface of Platen 15 x 5 in.
Traverse Movement 8 in.
Vertical Movement 9 in.
Stone 6 x 1/2 x 1/2 in.
Speed of c/shaft 400 r. p. m.
Weight 435 lbs.

$125.00

Write for Catalogue

NEW JERSEY MACHINERY EXCHANGE
NEWARK NEW JERSEY



Above cut shows our No. 48 Motor Driven Grinding Machine. It is built to do the heaviest kind of grinding and especially in steel foundries.

Size of wheels 24 x 4" Weight about 4000 lbs.
Size of journals 15 x 3¼" H. P. of motor 10

As shown above, it is equipped with Ransom Patent Speed Controller and without guards. Different types of guards can be furnished.

If interested, send for our Catalogue.

Ransom Manufacturing Co.

OSHKOSH, WISCONSIN, U. S. A.

To Keep Your Tools in Cutting Order—

SIMMONS UNIVERSAL TOOL AND CUTTER GRINDER

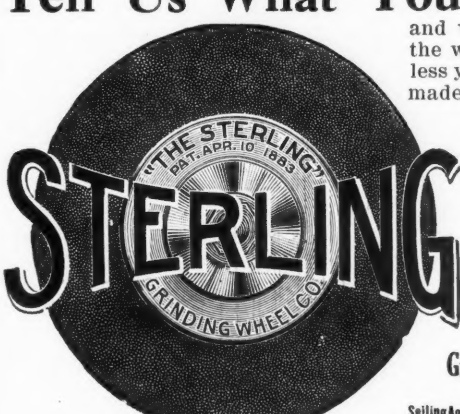
You know the advantages of sharp tools; but do you know the merits of the Simmons Tool and Cutter Grinder? It not merely keeps tools sharp, but puts an *accurate* edge on them. In addition to grinding cutters, reamers, counterbores, twist drills, etc., it is adapted for cylindrical and internal grinding. The efficiency of the Simmons "Universal" includes prompt delivery service.

Write for description.

SIMMONS MACHINE COMPANY, Inc.

987 Broadway **1001 Singer Bldg.**
ALBANY, N. Y. **NEW YORK CITY**

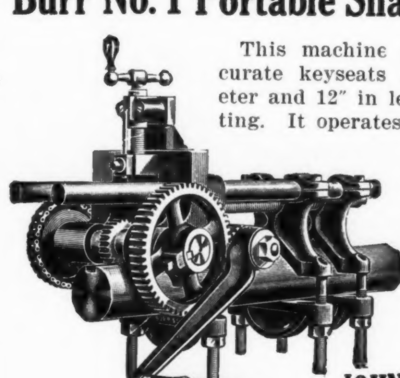
Tell Us What You Grind



and we will tell you the wheel to use. Unless you get *the* wheel made for the particular grinding you do, results cannot be the best — therefore Sterling Service goes with Sterling Wheels. Catalog.

The Sterling Grinding Wheel Co.
TIFFIN, OHIO
Selling Agency: New York, 75 Barclay St.
Chicago Store: 30 N. Clinton St.

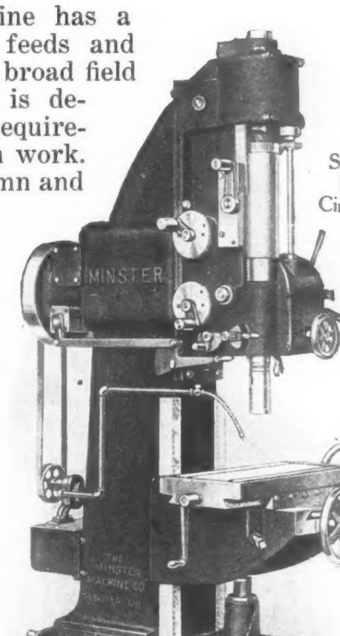
Burr No. 1 Portable Shaft Keyseater



This machine cuts absolutely accurate keyseats up to 5" in diameter and 12" in length without resetting. It operates without chatter or jar, is very fast, easy to set up and remove, and can be used in practically any position. Has automatic feed and adjustable depth gauge.

JOHN T. BURR & SON
429 Kent Ave., Brooklyn, N. Y.

THE MINSTER HI-DUTY DRILL

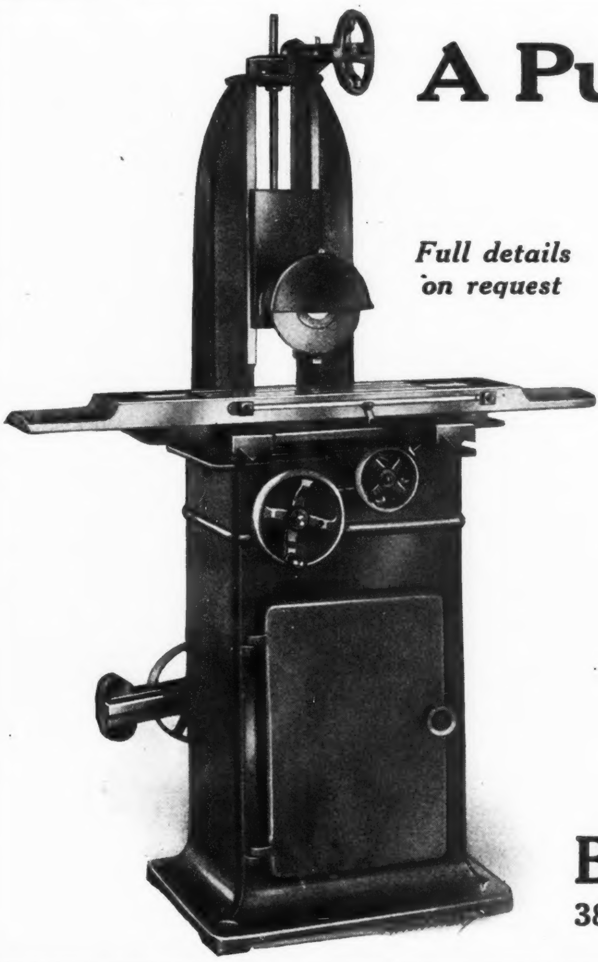


Send for Circular

This new machine has a wide range of feeds and speeds, covers a broad field of drilling and is designed to meet requirements of modern work. The massive column and heavy table give ample rigidity for heavy duty; a special spindle construction provides for small high speed drilling as well as heavy work; flood lubrication of all gears, ball thrust bearings on pulley and spindle and correct balance insure smooth running. Driving pulley speed 550 R. P. M. Drills in solid steel up to 2½".

THE MINSTER MACHINE CO.

MINSTER! OHIO, U. S. A.



A Pull to Start— A Push to Stop

Full details on request

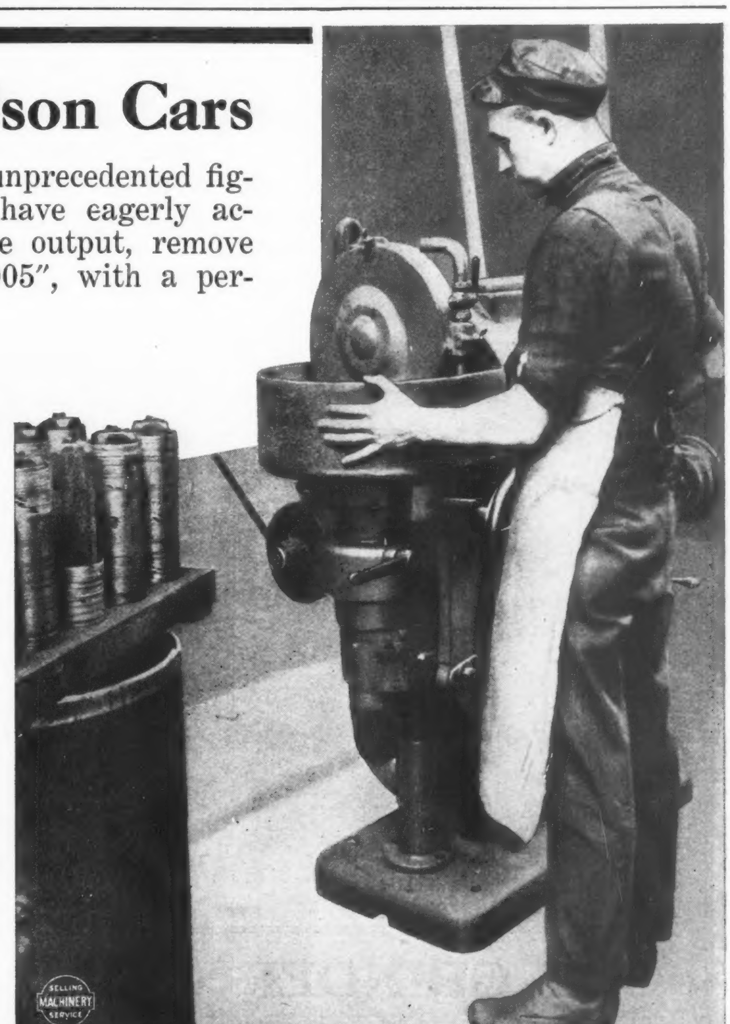
Simplicity is a dominant characteristic of the Reid No. 2 Surface Grinder and its influence is direct in promoting ease and convenience of operation. *A pull* on a rod operating from the center of the longitudinal feed wheel *starts* the machine, a *push stops* it. Table travel is automatic in either direction and can be reversed by dogs at the front side of the table that trip the reversing lever. Feed, which is positive, may be set to operate at end of each stroke or at the end of a complete forward and return stroke, and may be varied from 0.007″ to 0.084″. The machine is designed for production grinding as well as toolroom operation and will handle work up to 18″ length, 6″ width and 12″ height. Wheel spindle takes wheels up to 7″ diameter, ½″ face and ¾″ hole.

Boston Scale & Machine Co.

381-389 Congress Street BOSTON, MASS.

Piston Rings for Hudson Cars

Piston ring production has reached such unprecedented figures that manufacturers of such parts have eagerly accepted a machine which will increase the output, remove stock quickly and hold to a limit of .0005″, with a perfect finish.



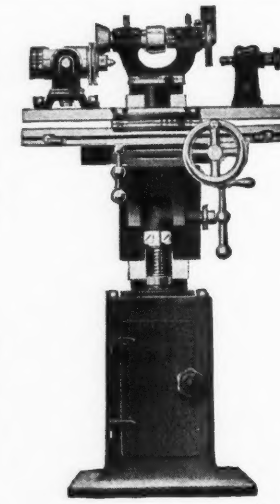
Persons-Arter Grinders

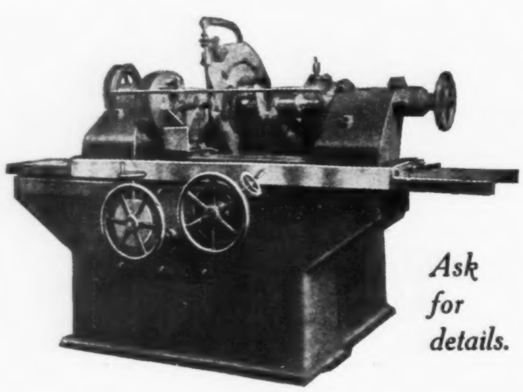
are the machines which get the preference in so many shops because of their exceptional speed, accuracy, convenience and economy. You undoubtedly have work that could be handled to better advantage on Persons-Arter Grinders. Tell us what you grind—will be glad to point out the improvement these machines will insure.

Send for catalog, too.

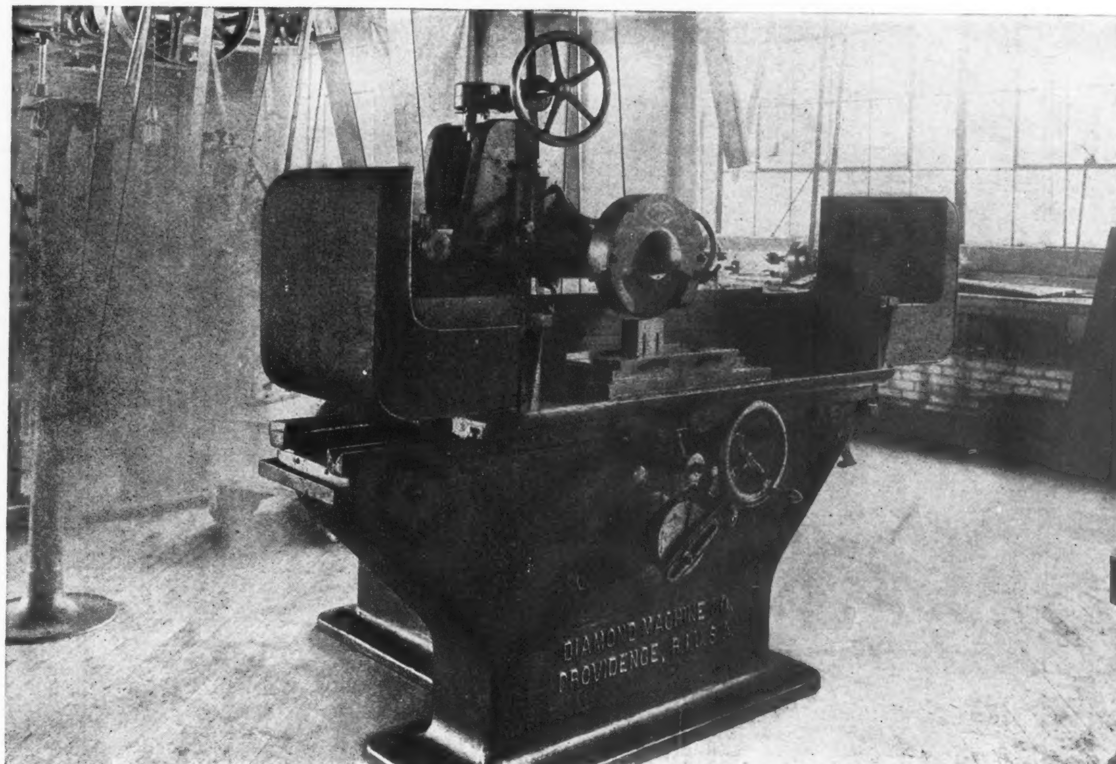
THE PERSONS-ARTER MACHINE COMPANY

WORCESTER MASS.






OTT
GRINDER
Co.
INDIANAPOLIS
IND. U.S.A.



The Diamond Surface Grinder in the National Scale Works

The biggest thing in sight, in this corner of the toolroom at the National Scale Company's shops, is the Diamond Surface Grinder.

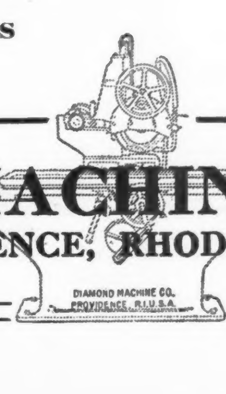
It's a big producer—" . . . a wonderful producer," they call it in a recent letter, and add that it is giving them "excellent satisfaction."

In the National's shop the "Diamond" is used principally for grinding the sides of dies, from the rough, and for re-sharpening—an average of .005 to 1/16″ of stock being removed from each surface.

Such work is by no means the extent of the "Diamond" range. It gives excellent service on surfacing anything from cutlery to castings.

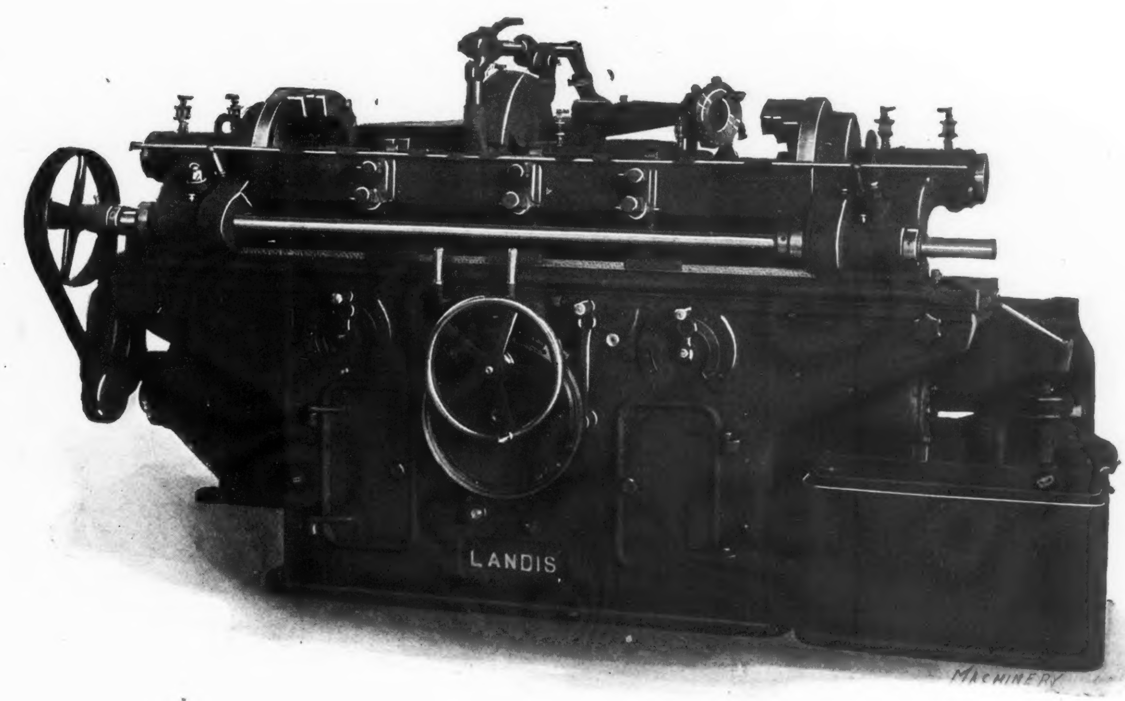
DIAMOND SURFACE GRINDERS
are easy to operate, accurate, rapid and economical.

Complete Catalogue on Request.



DIAMOND MACHINE COMPANY

PROVIDENCE, RHODE ISLAND



LANDIS

We'd like to send you the catalogue and show you just what to expect from LANDIS Grinding Machines. Send drawings along for figures—we'll be glad to prepare them. Grinding machines for all manufacturing purposes.

LANDIS TOOL COMPANY

Main Office and Works

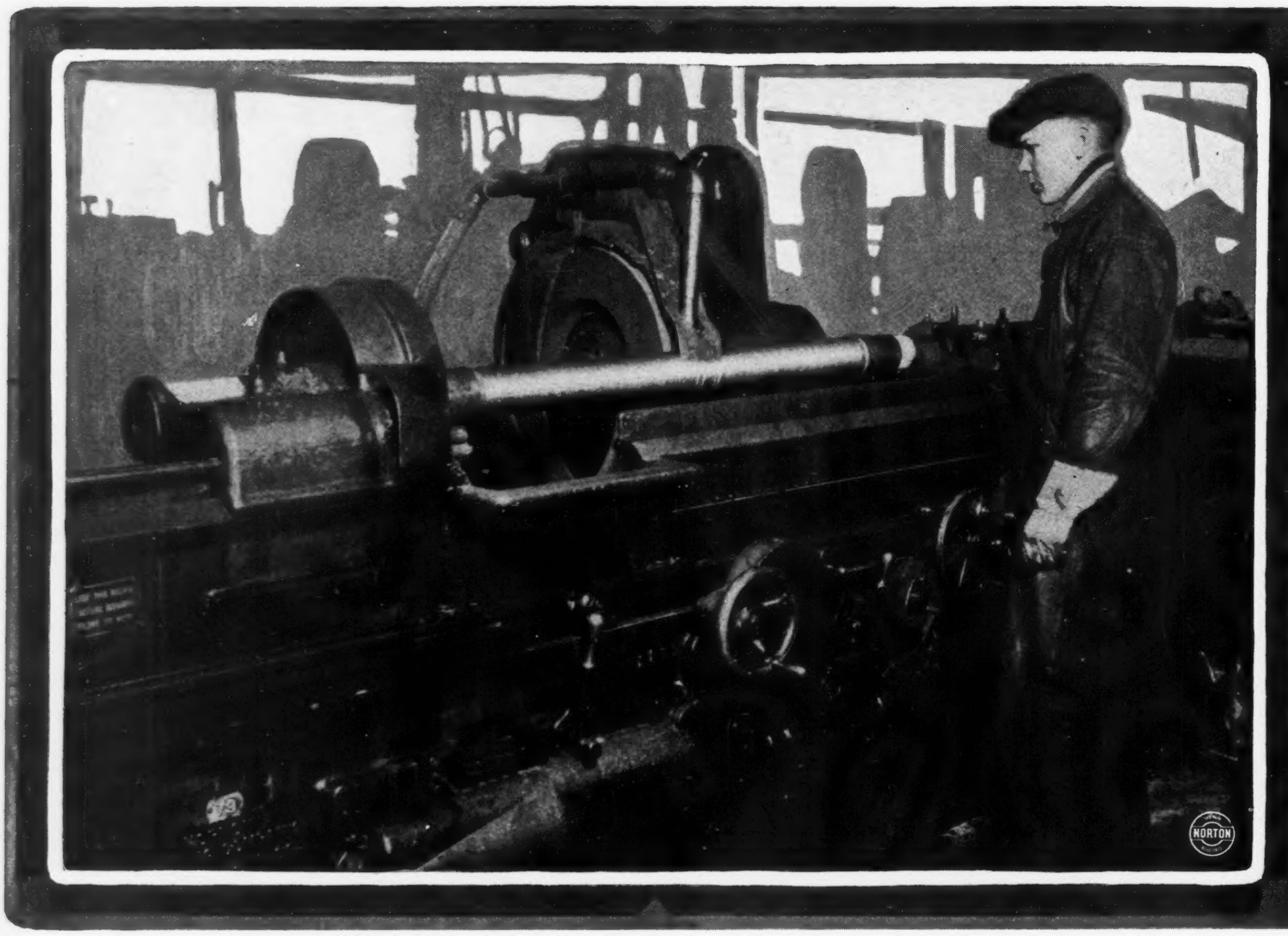
WAYNESBORO
PA. U. S. A.

It's Not Difficult to Secure New Business

Not when you can refer New Business to Old Business—not when the machines in use back up the claims you make for the machine you hope to sell.

And that is why it is easy to sell LANDIS Grinding Machines to men who have work for them to do. LANDIS Grinding Machines, in use all over the world, back up every claim we make for them. They are correct in design—the grinding wheel travels and the work table is stationary—production is large—accuracy is just as close as you may want to make it—finish is unsurpassed.

More weight, less floor space. More work, less wheel expense—and it is all in the design. Ask any LANDIS user.



Grinding "Big Four" Piston Rods

THIS photograph was taken in a large eastern railway shop and shows a "Big Four" piston rod being ground on a NORTON machine and with a NORTON wheel.

The wheel used is a 24 x 3⅞ x 5", 24 combination, grade M, ALUNDUM, and is giving satisfactory results.

Under slightly different conditions a 24 combination L ALUNDUM has also proven satisfactory.

TRADE MARK NORTON REGISTERED

NORTON COMPANY

WORCESTER, MASS.

ELECTRIC FURNACE PLANTS

New York Store	**Chippawa, Ont., Can.**	**Chicago Store**
151 Chambers St.	**Niagara Falls, N. Y.**	**11 N. Jefferson St.**

The New YANKEE
Drill Grinder

All it has cost the owner of this "New Yankee" for ten years' drill saving service is the *price of oil and grinding wheels.*

Granted a first-class drilling machine, the chief factor essential to high production is accurately ground drills. "New Yankee" accuracy is positive and uniform. The machine is so simple a wide-awake boy can run it.

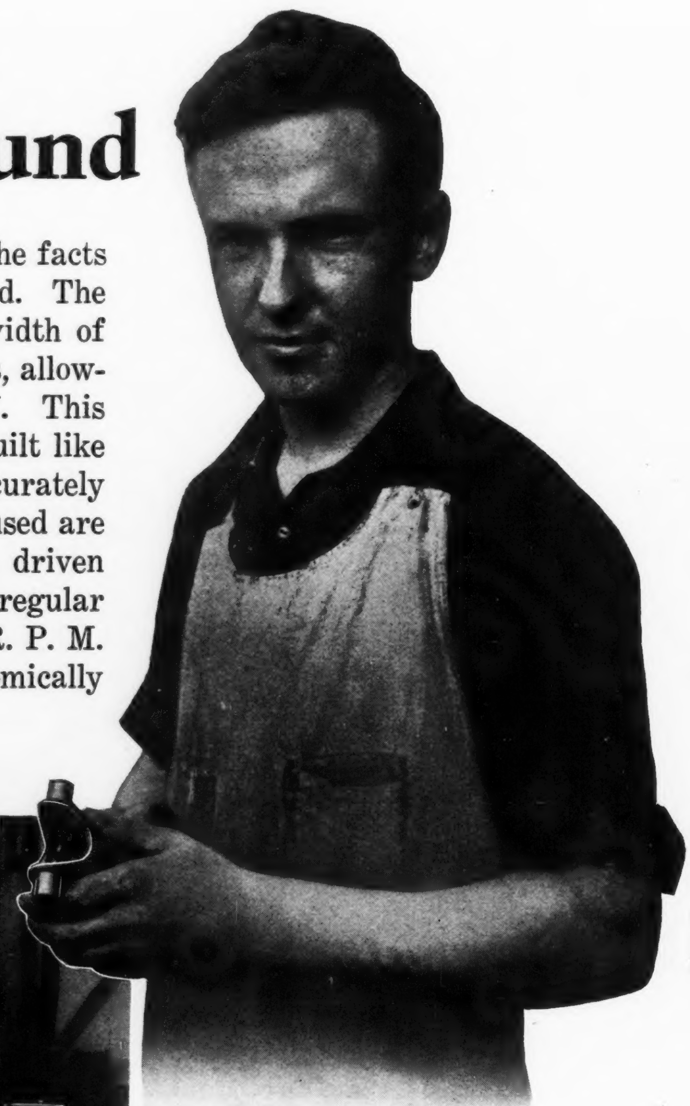
Over Ten Years' Service and Not a Cent for Repairs

It does its work so efficiently that from 50 to 75% is saved on drill costs. There's a "New Yankee" to meet every modern drill grinding requirement Write for catalog No. 106.

Wilmarth & Morman Co.

2180 Monroe Ave., N.W.
Grand Rapids, Mich.

Manufacturers of Drill Grinders, Surface Grinders, Universal Grinders.



"ABRASIVE" GRINDING WHEELS
EXCLUSIVELY

Mr. Storekeeper in one of the steel casting companies has seen a good many grinding wheels come—and go. Then he saw Abrasive Wheels enter the lists, and not only stay, but crowd every other grinding wheel out. It takes "bite," and plenty of it, to handle his company's grinding efficiently and economically. There's "bite" in every abrasive grain. Moreover, Abrasive Wheels are uniform. When a man asks for a duplicate of the wheel he's been using, he gets that particular wheel's "twin."

They've Got the "Bite"

Abrasive Wheels are a sure aid to lower production costs. If your work is material of high tensile strength it calls for "Boro-Carbone" Wheels. For low tensile strength materials we recommend "Electrolon" Wheels. Should you have grinding problems, don't worry about them—send them to us.

New Abrasive Catalog on request.

ABRASIVE COMPANY
BRIDESBURG PHILADELPHIA, U.S.A.

Chicago Branch, 566 W. Washington Blvd.

"ABRASIVE"
GRINDING WHEELS

ABRASIVE ORDER No. B 87180
CUSTOMER ORDER No. 13159
SIZE 18x2x2
GRAIN 14 GRADE Q FACE No.
SHAPE SAFETY
TESTED AT 1925
SPEED RECOMMENDED
R. P. M. 1925 to 1275

Speed within above range is dependent on condition of machine, method of grinding and safety appliances used.

Abrasive Material Co.
BRIDESBURG, PHILADELPHIA, U. S. A.
Chicago Branch. 566 W. Randolph St.

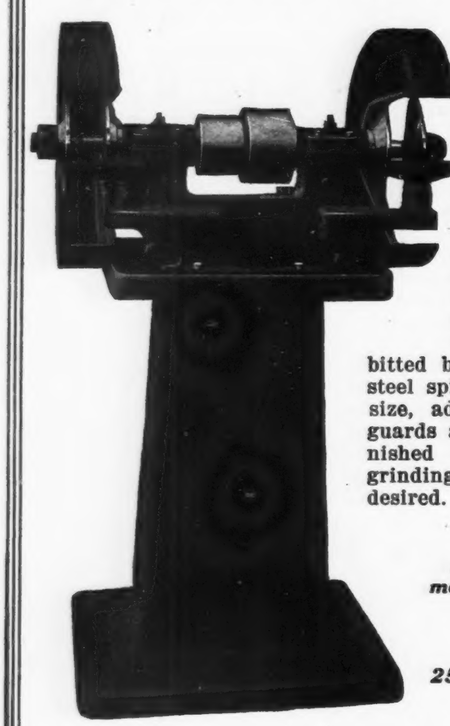
Retain tag for duplicate order. (OVER)

Detroit High Grade Grinding Wheels—A Dependable Source of Supply

We furnish reliable wheels for any grinding operation and fill re-orders with *exact duplicates, at economical figures.* If you are not grinding with Detroit Wheels just give the line a trial. Catalog.

DETROIT GRINDING WHEEL CO.
DETROIT, MICHIGAN, U. S. A.

The BLOUNT No. 5 Grinder



provides grinding facilities for two men. It's a space and power saver, designed and built to give efficient service. It is rigid, strong and maintains a smooth, even speed. Has self-oiling line reamed babbitted bearings, carbon steel spindle ground to size, adjustable wheel guards and can be furnished with surface grinding attachment if desired.

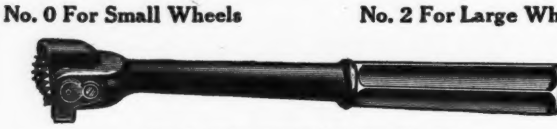
Let us tell you more about Blount Grinders

25 Years on the Market

J. G. BLOUNT COMPANY
EVERETT MASS., U. S. A.

EMERY WHEEL DRESSERS

No. 0 For Small Wheels **No. 2 For Large Wheels**



NO. 1 FOR REGULAR SHOP USE

These Dressers in connection with our Cutters make a most powerful and efficient tool, especially our No. 0 for small wheels 6 inches and under, and No. 2 which is made proportionately larger and stronger for large wheels.

CUTTERS

We make the regular "Huntington" (pattern) for No. 0 and "Huntington" (pattern) Paragon Cutter and Roughing Cutter for Dresser No. 1 and the "Huntington" (pattern) and Roughing Cutters for Dresser No. 2. Let us send you descriptive circular and prices.

GEO. H. CALDER, Lancaster, Pa., U. S. A.

LATHE CENTER GRINDER

Will grind lathe centers mechanically with scientific accuracy in fraction of time required with other methods.

Builders of "Ideal" Patented Portable Electric Tools, Grinders, Drills, Saws, Screw Drivers, Nut, Bolt and Lag Screw Setters.

THE NEIL & SMITH ELECTRIC TOOL CO.
Cincinnati, Ohio, U. S. A.

Ask for Circular M

The Reason They're Vitrified

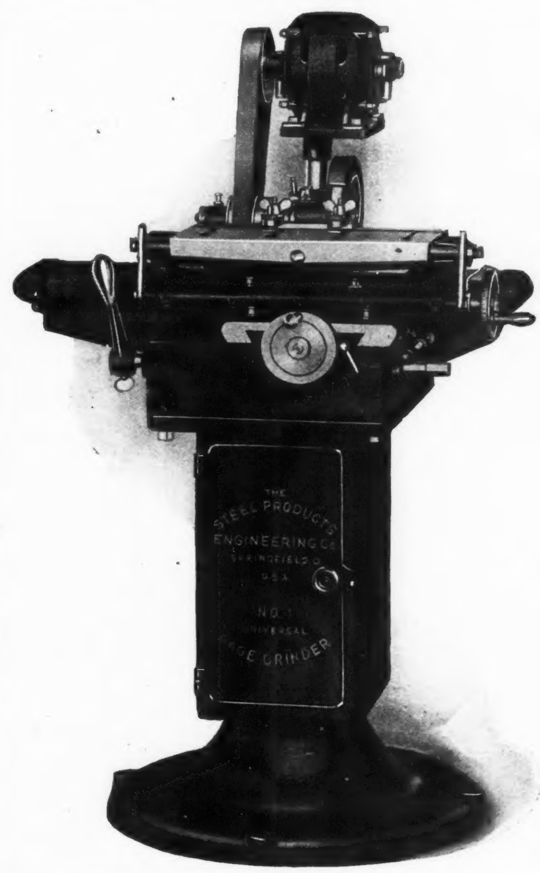
Vitrified Grinding Wheels are vitrified to harden the bond, which hardening gives it almost the cutting quality of the abrasive it binds. In addition the evaporation of moisture, due to the intense heat necessary for vitrification, renders the wheels porous, makes them free cutters and eliminates all possibility of glazing or creating sufficient heat to draw temper from the tools.

Vitrified Grinding Wheels are made in all required shapes and sizes. We guarantee satisfaction—replacing any wheel not giving satisfactory service.

Send for Catalog 8

Vitrified Wheel Company
Westfield Mass., U. S. A.

Gauge Grinding



With this machine you get the very highest degree of accuracy with the least possible expense.

Particular attention is called to the flat table and the provisions that have been made for quick, easy adjustments. It is very simple throughout and easy to operate.

Are you familiar with all the details that have helped to make this machine a success?

Let us help you acquire them.

THE STEEL PRODUCTS ENGINEERING CO.

SPRINGFIELD OHIO

Bryant Chucking Grinder Company

Springfield, Vermont, U. S. A.

Detroit Office: 924 Dime Bank Bldg., Detroit, Mich.

Builders of One, Two and Three Spindle Chucking Grinders.

$75.00 No Better Grinder for the Money

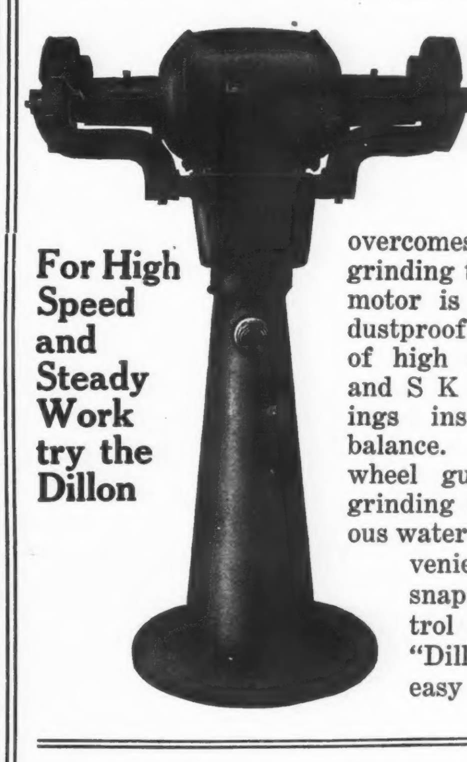
At this price the "Waterbury" Toolroom Die and Surface Grinder is surely a paying investment. It is adapted for a wide variety of work, is fast and accurate, fitted with up-to-date conveniences and means for compensating wear, strong and rigid throughout, lasting in service. Better values for the money would indeed be hard to find.

Detailed description on request

The Blake & Johnson Co.

WATERBURY, CONN.

Solid Comfort in Grinding



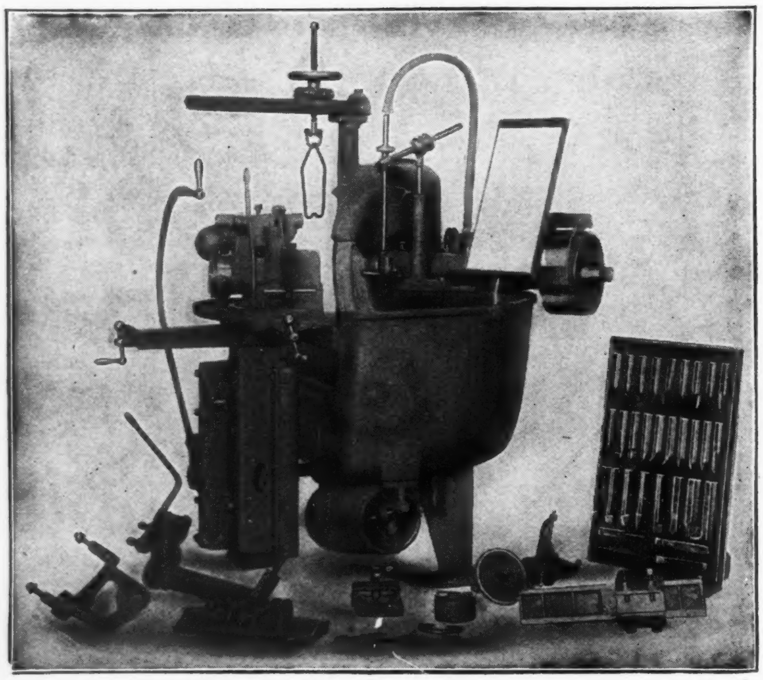
The DILLON Electric Grinder

For High Speed and Steady Work try the Dillon

overcomes the usual grinding troubles. The motor is rugged and dustproof. Large shaft of high carbon steel and S K F ball bearings insure perfect balance. Extra heavy wheel guards, broad grinding rests, generous water cup and conveniently placed snap switch control make the "Dillon" safe and easy to operate.

THE DILLON ELECTRIC COMPANY

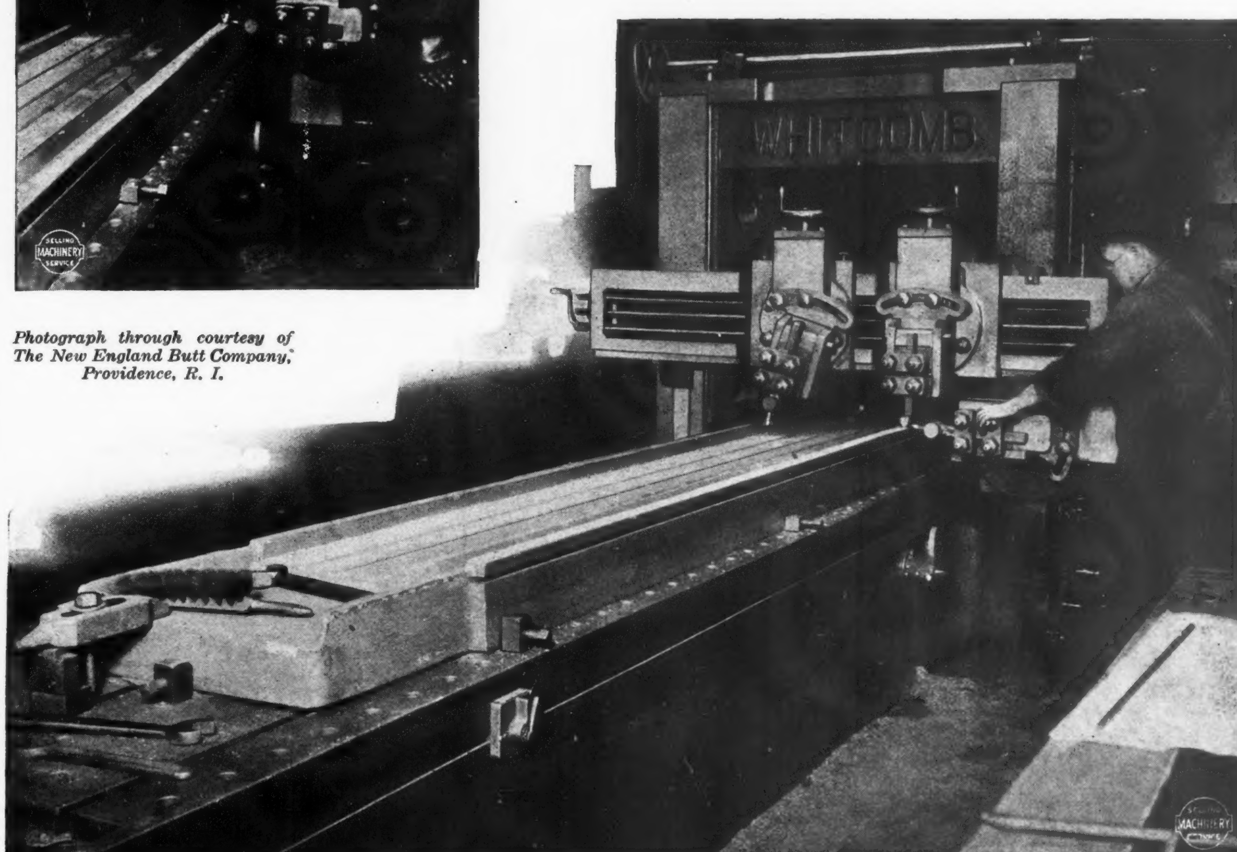
CANTON OHIO, U. S. A.



A Whitcomb-Blaisdell Planer

Photograph through courtesy of The New England Butt Company, Providence, R. I.

Which is Described by Its Operator as "One of the Finest Machines in the City of Providence"



There are other planers in this plant but the Whitcomb-Blaisdell 36" x 42" x 14' Planer, with its three heads, individual motor drive, hand-operated dogs, trouble-proof head-raising mechanism and second-belt features is the leader of them all—and we have the company's own word for it.

On work such as illustrated, planing large grinder bases, the roughing cuts are as heavy as one-half inch, through sand, scale and tough iron; but it is impossible to stall the planer. And it takes the finishing cuts to just as close limits as are needed.

When you buy a Whitcomb-Blaisdell Planer you get the maximum in planer service. Let us send the catalogue.

WHITCOMB-BLAISDELL MACHINE TOOL CO.

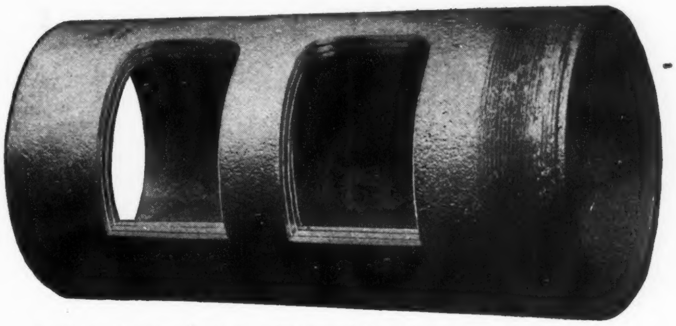
WORCESTER, MASS., U. S. A.

Remarkable Ductility of "NATIONAL" Pipe

170 quarts of nitroglycerine failed to crack this piece of "NATIONAL" Casing. The terrific force of the explosion reduced the length from about 18 feet to less than 6; although crushed, twisted and distorted there was no fracture.

"NATIONAL" Pipe for Mechanical Purposes

This piece of 10-inch "NATIONAL" Casing dropped 236 feet through a 12½-inch hole without fracturing the material. Although the end is distorted, as the thread protector was driven up over the threads by the force of the impact, THE MATERIAL SHOWS NO SIGN OF FRACTURE.



1440 feet of 8¼-inch "NATIONAL" Casing dropped 200 feet in a well, and as a result of the impact on solid stone three sections of the casing were telescoped with NO SIGN OF FRACTURE.

These three illustrations should be convincing proof of the extraordinary ductility of "NATIONAL" Pipe. No mill test ever devised could equal the terrific strains effected by the unusual accidents which produced the results shown.

¶ It is therefore a reasonable deduction that as "NATIONAL" Pipe has withstood such enormous forces without a fracture in the material, it is essentially qualified to withstand the strains incident to the mechanical uses for which it is recommended.

¶ As a matter of fact "NATIONAL" Pipe is used for thousands of parts of different machines which are used for thousands of different purposes.

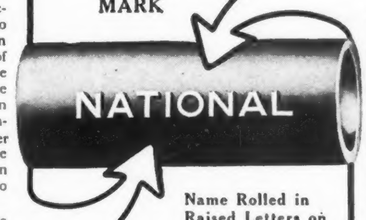
¶ The inherent ductility of "NATIONAL" Pipe lends itself most satisfactorily to mechanical manipulations, and in service withstands without failure the jars and shocks to which the incessant vibrations of machinery are inevitably subjected.

¶ To readily identify "NATIONAL" material and as protection to manufacturer and consumer alike, the practice of National Tube Company is to roll in raised letters of good size on each few feet of every length of welded pipe the name "NATIONAL" (except on the smaller butt-weld sizes, on which this is not mechanically feasible: on these smaller butt-weld sizes the name "NATIONAL" appears on the metal tag attached to each bundle of pipe).

¶ When writing specifications or ordering tubular goods, always specify "NATIONAL" pipe, and identify as indicated.

AWARDED

LOOK FOR THE MARK



Name Rolled in Raised Letters on National Tube Company Pipe

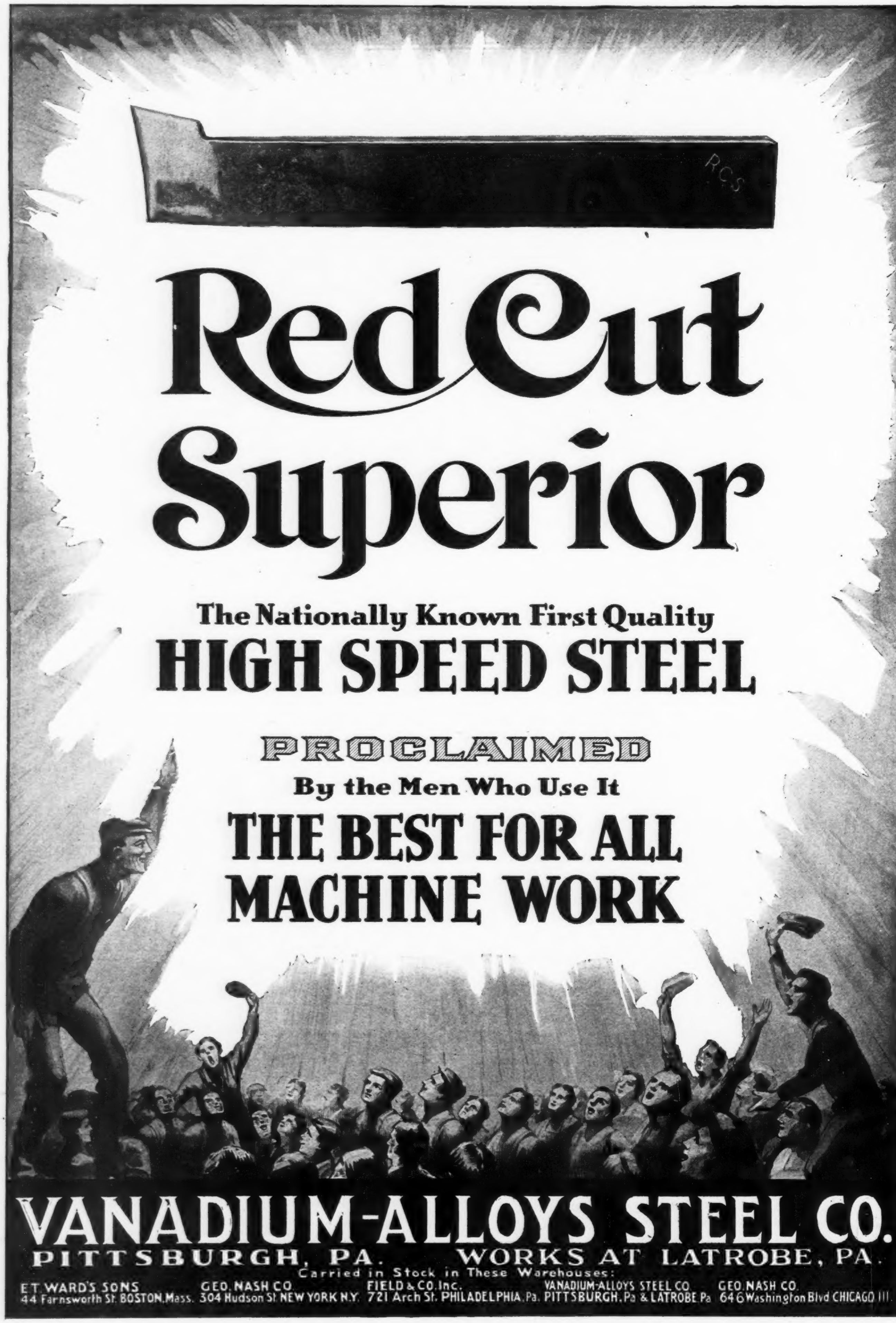
¶ In addition, all sizes of "NATIONAL" welded pipe four in. and under are subjected to a roll-knobbling process known as Spellerizing to lessen the tendency to corrosion, especially in the form of pitting. This Spellerizing process is peculiar to "NATIONAL" pipe, to which process National Tube Company has exclusive rights.

¶ "NATIONAL" pipe was awarded the GRAND PRIZE (highest possible award) at Panama Pacific International Exposition, 1915.

AWARDED

NATIONAL TUBE COMPANY, General Sales Offices Frick Building PITTSBURGH, PA.

DISTRICT SALES OFFICES: Atlanta Boston Chicago Denver Kansas City New Orleans New York Omaha Philadelphia Pittsburgh St. Louis St. Paul Salt Lake City
PACIFIC COAST REPRESENTATIVES: U. S. Steel Products Co., San Francisco Los Angeles Portland Seattle
EXPORT REPRESENTATIVES: U. S. Steel Products Co., New York City.



RCS
Red Cut
Superior
The Nationally Known First Quality
HIGH SPEED STEEL
PROCLAIMED
By the Men Who Use It
THE BEST FOR ALL
MACHINE WORK
VANADIUM-ALLOYS STEEL CO.
PITTSBURGH, PA. WORKS AT LATROBE, PA.
Carried in Stock in These Warehouses:
E.T. WARD'S SONS 44 Farnsworth St. BOSTON, Mass.
GEO. NASH CO. 304 Hudson St. NEW YORK N.Y.
FIELD & CO. Inc. 721 Arch St. PHILADELPHIA, Pa.
VANADIUM-ALLOYS STEEL CO. PITTSBURGH, Pa & LATROBE Pa
GEO. NASH CO. 646 Washington Blvd CHICAGO Ill.

A New Chain-Pipe Wrench

by the

Billings & Spencer Company

The above cut shows the wrench in its two positions

which, for the first time in the construction of this type of wrench, accomplishes reversibility of action —works either way without disengaging and turning.

The Billings Chain-Pipe Wrench, because of its new and exclusive feature, saves many an hour and solves many an awkward situation. Read the facts:

The important and exclusive feature of this wrench is its double-action or reversibility. Pipe can be turned in either direction without the process of removing and turning over the wrench. This is due to the angular position of the elliptical jaws, which allows the engagement of either the outer or inner teeth.

The combination feature of this wrench consists of its adaptability to pipe fittings and short connections, as well as ordinary pipe. By removing the outside elliptical jaws, thereby bringing into play the narrow jaw attached to the under part of the handle, the wrench is immediately converted into an efficient tool for narrow or irregular work where a broader wrench would be ineffectual.

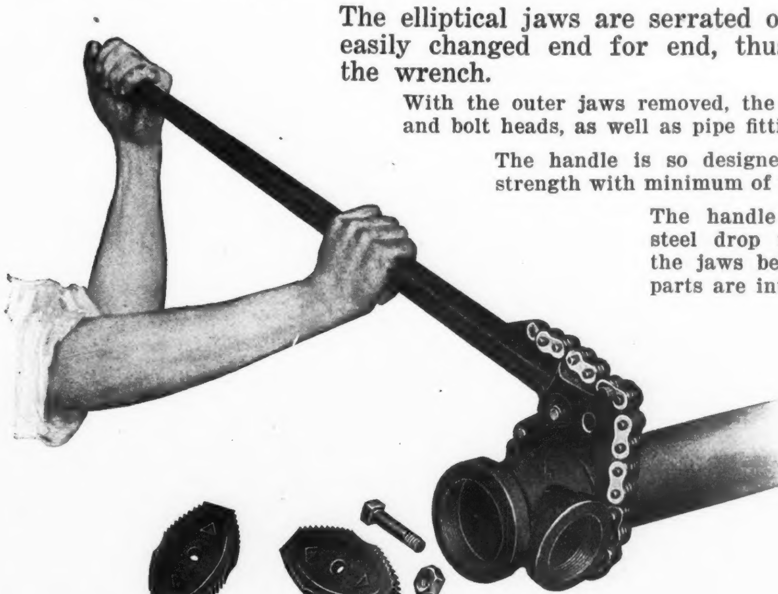
The elliptical jaws are serrated on all sides and may be easily changed end for end, thus giving double life to the wrench.

With the outer jaws removed, the wrench is available for nut and bolt heads, as well as pipe fittings.

The handle is so designed as to give the necessary strength with minimum of weight.

The handle and jaws are made from steel drop forging of superior quality, the jaws being carefully hardened. All parts are interchangeable.

The tool is made with either a flat link or cable chain. The chains are made in our own factory, and are of sufficient safety-test to insure an absolutely reliable tool.



The above cut shows the wrench as adapted to fitting nipples, etc.

Prompt Deliveries

Descriptive literature and price lists upon request.

THE BILLINGS & SPENCER CO.
HARTFORD, CONN. U.S.A.

STARRETT TOOLS TRADE MARK REG. U.S. PAT. OFF.

TRADE MARK

Starrett Tools

REG. U.S. PAT. OFF.

Tell the Truth

After all, the principle of micrometers and other fine measuring tools is quite simple. The only requirement is that they tell the truth.

This test indicator, for example, has done its full duty when it has registered its story in thousandths.

Starrett Tools have a reputation for truth telling. Their character is well established. That's why it pays to use the line of 2100 styles and sizes of micrometers, calipers, gages, squares, height and depth gages, and other precision tools described in our Catalog No. 21 D.

The L. S. Starrett Co., Athol, Mass.

The World's Greatest Toolmakers

42-682


Properly Treated Alloys and Metals That Answer Any Condition or Requirement
PRECISION DIE CASTINGS
protect you against the burden of increased cost of materials.
The Precision Organization is *precise* in die making—in alloying metals—in castings and in deliveries.
Our representative will gladly call and show you samples.
PRECISION DIE CASTING CO.
INCORPORATED
SYRACUSE, N. Y.
Castings in aluminum alloys, all bearing metals, spelter and lead.
Special requirements given prompt attention. Representatives in New York, Cleveland and Detroit.
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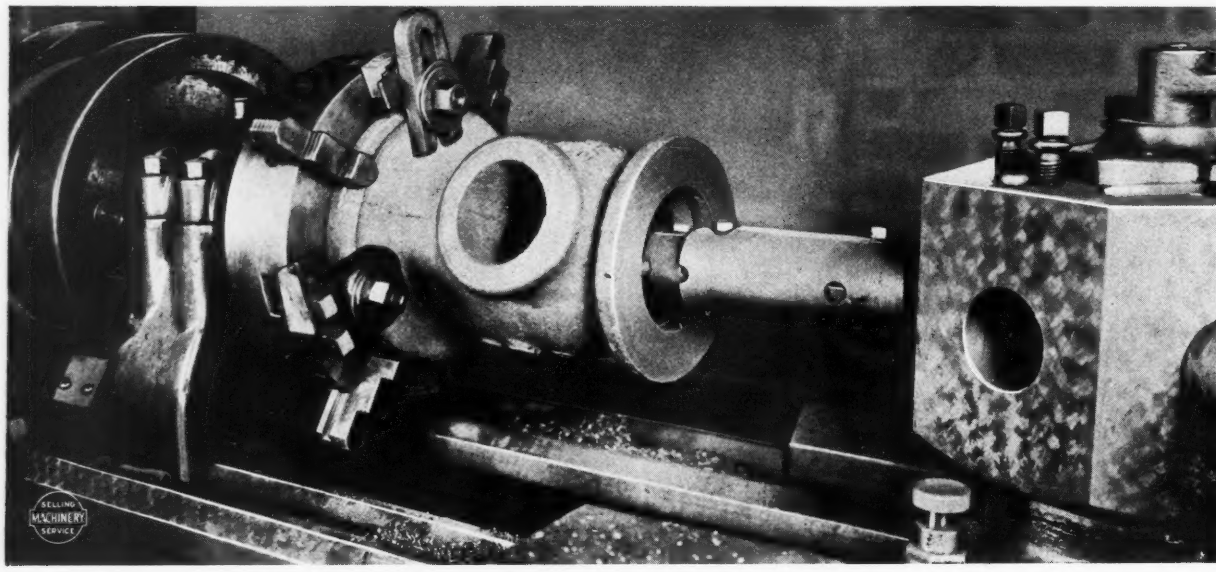
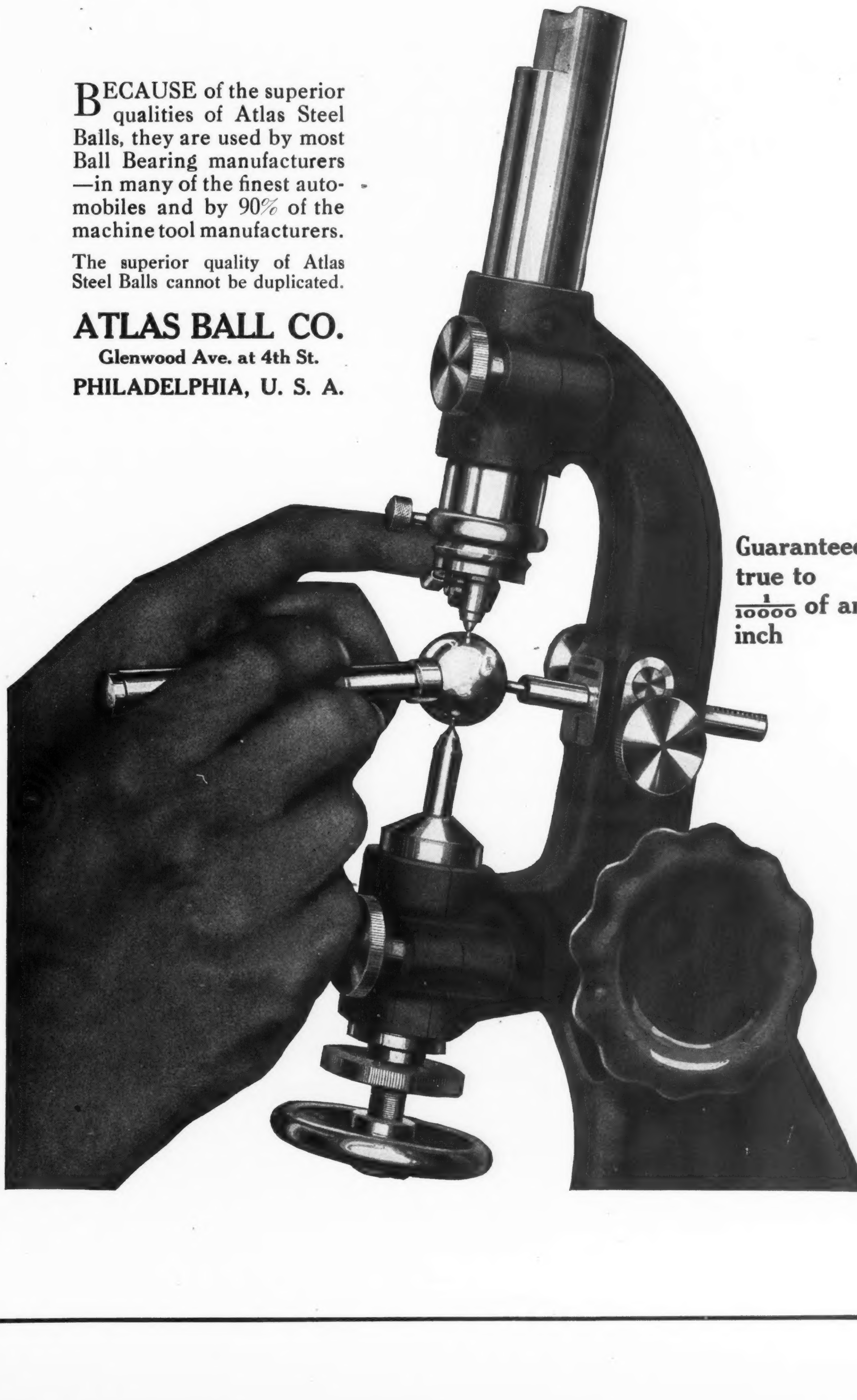
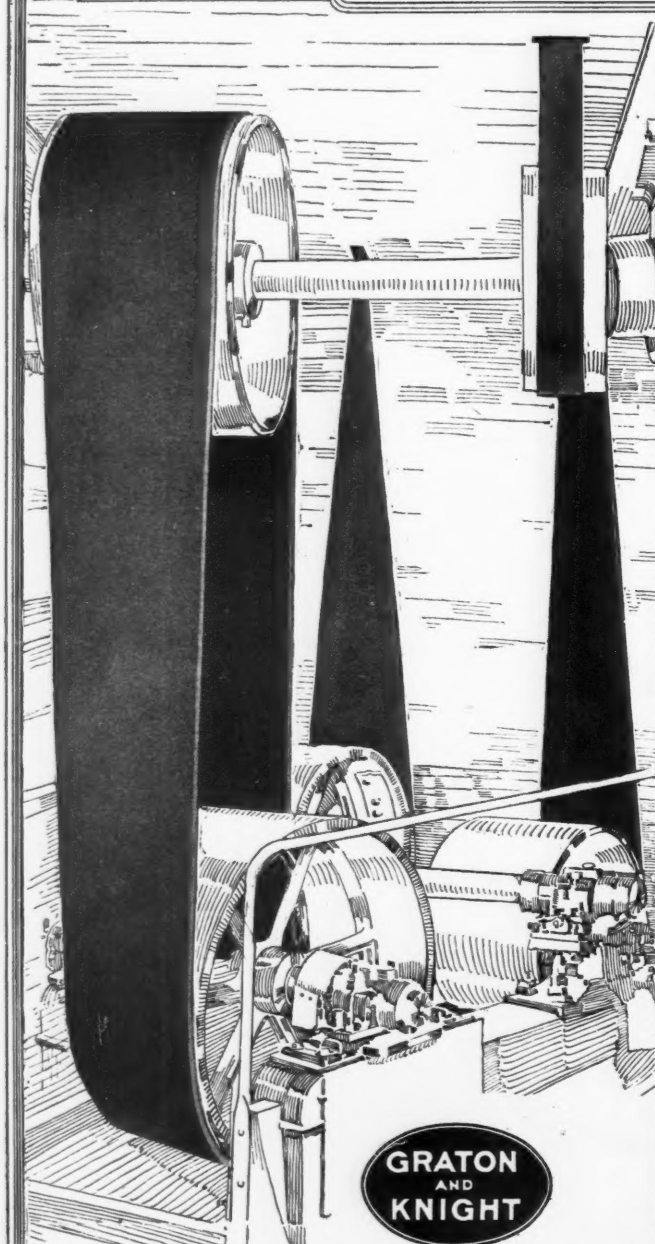




GRATON & KNIGHT
Standardized Series
LEATHER BELTING

Tanned by us for belting use



24" Spartan Double Belt, one of Graton & Knight Standardized Series Leather Belts, on Five Pulley Quarter Turn Drive. Great Falls Bleachery & Dye Works, Somersworth, N. H.

It Begins in the Tannery

Leather is the standard belting material

To us, the largest belting makers in the world, every possible belting material lies open for selection and use. But the belting experience of generations points to the unescapable fact that leather has the properties necessary to make good belting.

Leather that is properly tanned for belting is tough, flexible, durable and prehensile. It preserves the natural softness and mobility of the skin, ensuring an effective grip on the pulley surface.

We have standardized these requirements of perfectly tanned belt leather. The standard in each case is the highest *working* efficiency in the finished belt.

Since the market cannot supply tanned belt leather that continuously measures up to Graton & Knight Standards, we tan our own hides. Last year we tanned 285,000 of them, in our own tannery. We tanned them for *belts*. We tanned them to definite and uniform standards of belting requirements.

This standardization of material is the foundation of Graton & Knight quality.

It makes the Standardization of Graton & Knight Belts an actual, practical thing.

Think what other standardized products have done for you—and consider the standardization of belting on that basis. Let us send you complete information on the subject.

The Graton & Knight Mfg. Company

Oak Leather Tanners and Makers of Leather Belting

Worcester, Massachusetts, U. S. A.

BRANCHES

Atlanta, Boston, Chicago, Cleveland, Detroit, Fall River, Kansas City, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Seattle, St. Louis, Leicester, England.

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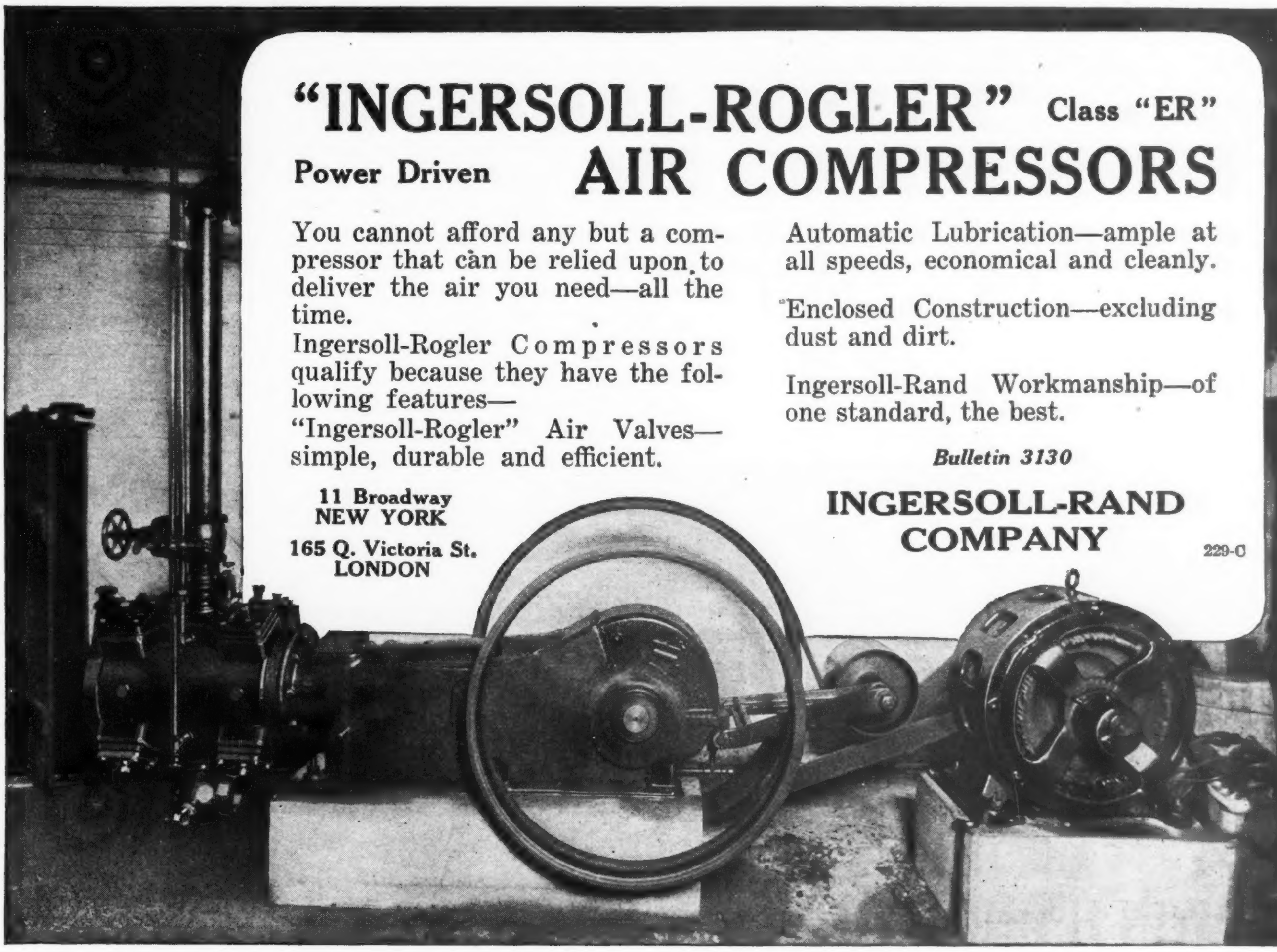

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Power Driven **AIR COMPRESSORS**

You cannot afford any but a compressor that can be relied upon to deliver the air you need—all the time.

Ingersoll-Rogler Compressors qualify because they have the following features—

"Ingersoll-Rogler" Air Valves—simple, durable and efficient.

Automatic Lubrication—ample at all speeds, economical and cleanly.

Enclosed Construction—excluding dust and dirt.

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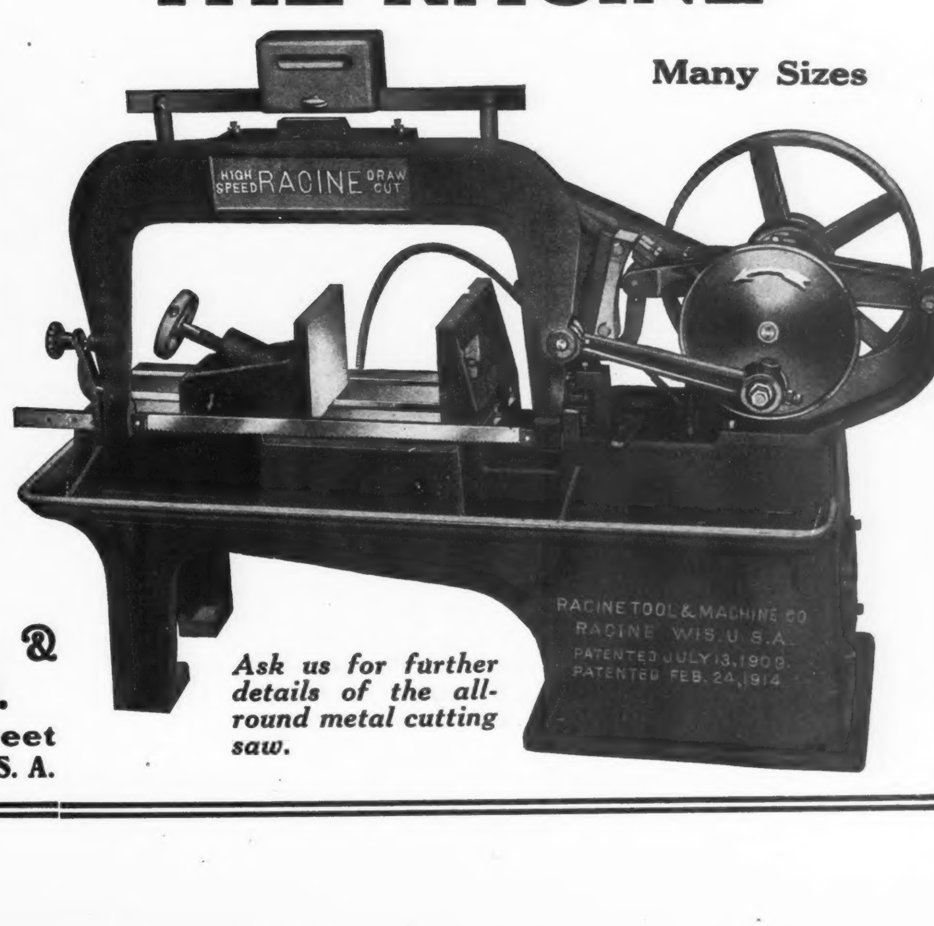
INGERSOLL-RAND COMPANY

229-C

For Fast, Heavy Duty Metal Cutting

THE RACINE

Many Sizes

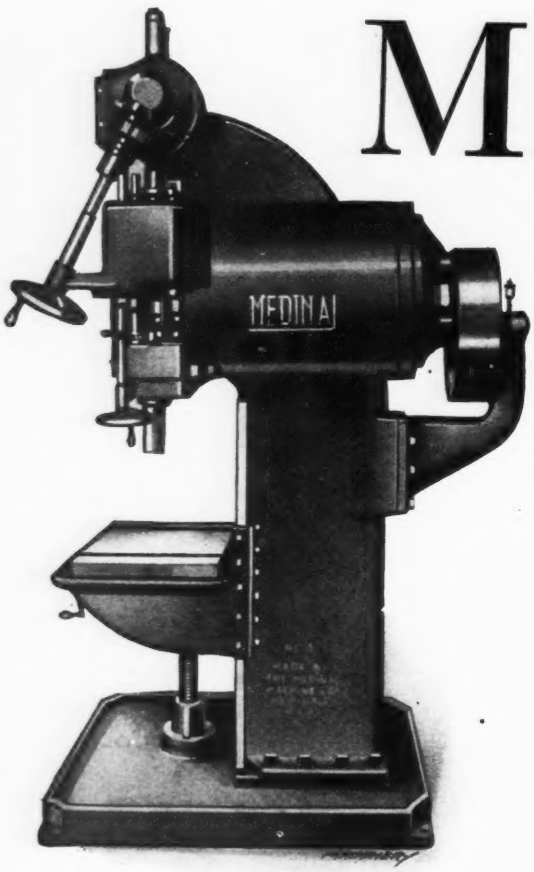


For cutting Angles, Channels, I-Beams, Die Blocks, Pipe, Tubing, etc., at high speed, this Racine Machine leads the pack. It is equipped with the patent return stroke, automatic lifting device—original with these machines— which means higher output and greater blade economy than is possible with any similar machine of equal capacity. Blades can be tightened without wrenches, saw-frame holds itself automatically at any height, stock can be held firmly at any angle and short lengths cut without trouble.

Ask us for further details of the all-round metal cutting saw.

RACINE TOOL & MACHINE CO.
250 Fifteenth Street
RACINE WIS., U. S. A.

MEDINA



A Powerful Machine for Heavy Manufacturing

To the experienced man there's evidence of *power* even in appearance, and some of accuracy, too; for the Medina has the proportion and balance and backing-up metal necessary for absolute rigidity. But for the *FULL* facts about the accuracy and output that make Medina Drilling Machines extra efficient for manufacturing purposes, it is necessary to go into detail.

Ask us—even if you're not in the market for drilling machines right now.

MEDINA MACHINE CO.
MEDINA, OHIO, U. S. A.

FLATHER

20" DOUBLE BACK GEARED LATHE

A masterpiece of high-grade machine tool construction. We have topped off "Flather" rigidity, power and speed with improved features which make this 20-in. lathe one of the most productive and profitable all-around lathes on the market. Before deciding on lathe equipment investigate Flather machines.

FLATHER & CO., Inc.
NASHUA, N. H.

LATHES

The Chicago Automatic

Built Around the Cornerstone of Simplicity

Chicago Automatic Machine Company
Chicago, Illinois, U. S. A.

Eastern Representative
John MacNab Machinery Co.
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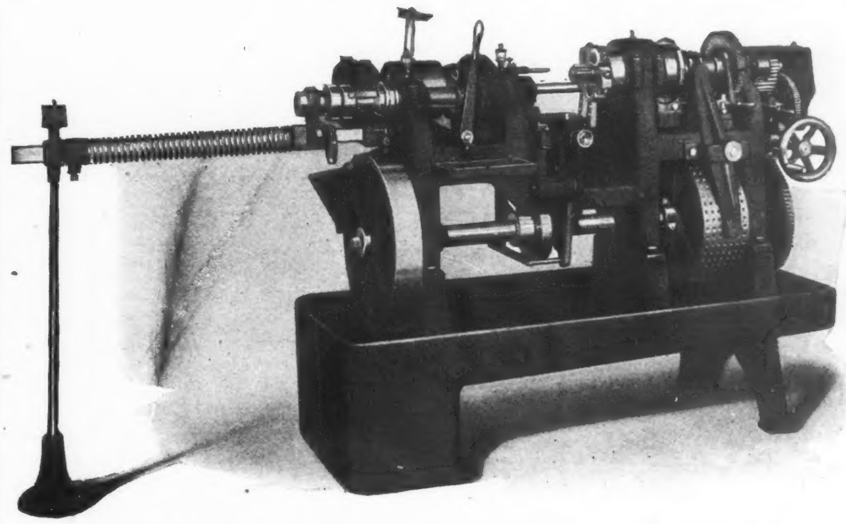
John MacNab, Hyde, England



The Chicago Automatic Screw Machine

owes a great deal of its serviceability to simple design. There are no complicated mechanisms or involved systems of cams to cause trouble; no countershafts and overhead belts to waste power and interfere with additional equipment, spindle speeds suitable for any stock are obtained by changing two gears on the spindle head; threads are cut withopt slowing spindle speed by means of a die holder revolving in the same direction as the spindle but at higher speed. A clutch mechanism indexes the turret and skips holes not in use. The machine is rigidly built throughout, maintaining alignments and accuracy of work under long, continuous operation.

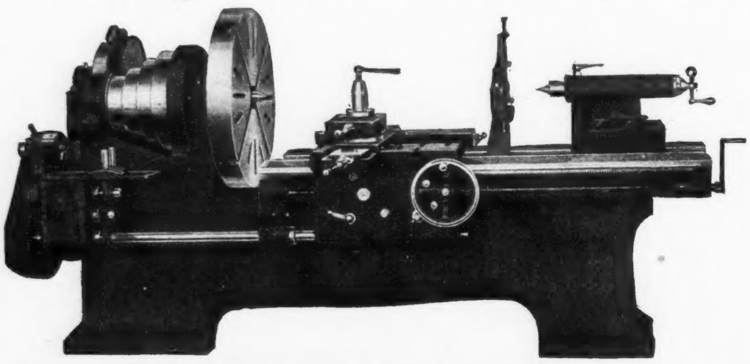
Write for complete description.

Get Acquainted with the New "Filsmith" Lathe

A 13″ engine lathe that swings 14″ over the bed and takes heavy cuts. The "Filsmith" Lathe is built up on a wide, deep, heavy-walled, box-girded bed, provided with solid, rigid, perfectly aligned headstock, full webbed type, and with tailstock to match. Spindle of 50-point carbon crucible steel, accurately finished by grinding, has bearings of finest grade phosphor bronze. These main features are typical of "Filsmith" construction throughout. Our purpose has been to construct an extra capacity small lathe—accurate, rapid and economical to use. We have succeeded. Let us show you. *Details on request.*

THE PHILIP SMITH MFG. CO., Sidney, Ohio

Two Lathes in One at a Great Saving in Cost—22-36" Gap Lathe



Our Heavy Duty Sliding Extension Gap Lathe is a most necessary tool to the shop with a wide range of work. Being practically two lathes in one, it is sure to be kept busy all the time.

This lathe has main and sliding beds, very heavy and broad. They are braced over their entire length. The lathe loses none of the accuracy and rigidity of the usual type lathe. It is equipped with powerful back gears—has 6 quick changes of geared feeds, 12 spindle speeds and cuts threads 2 to 30—all steel gears throughout.

Let us send full details in Bulletin "M."

BARNES DRILL COMPANY, Inc, 814 Chestnut Street, Rockford, Ill., U. S. A.

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Sawing, Filing and Lapping Machine

Meets Modern Demands

Write for Our Circular

The order of the day calls for the "latest models." Machines must be changed frequently to meet this demand—new parts must be designed, new patterns made. There is no time for the handmade dies of yesterday—yet the work must be just as accurate, just as well finished.

The OLIVER FILING AND LAPPING MACHINE is the solution of the skilled patternmaker's problem. He can devote all his time to planning and designing new parts while an ordinary mechanic cuts and finishes them in 30 to 60 per cent less time with the "Oliver."

Oliver Instrument Company
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Dwight Slate Trade Marking Mark Machine

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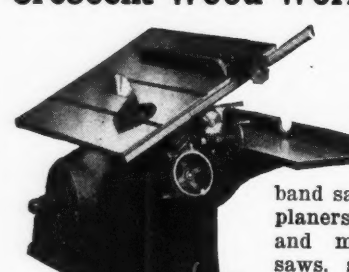
Trade Marks, Letters or Numbers put on your work at REDUCED COST with quality improved by these machines. Lettering Dies cut by EXPERT ENGRAVERS.

Noble & Westbrook Mfg. Co.
Hartford, Conn. U. S. A.

Crescent Wood Working Machinery



will satisfy those particular buyers who want enduring service in wood working equipment. Ask today for catalog telling about our line of band saws, jointers, saw tables, planers, disk grinders, planers and matchers, swing cut-off saws, shapers, borers, hollow chisel mortisers, variety and universal wood workers.

THE CRESCENT MACHINE CO.
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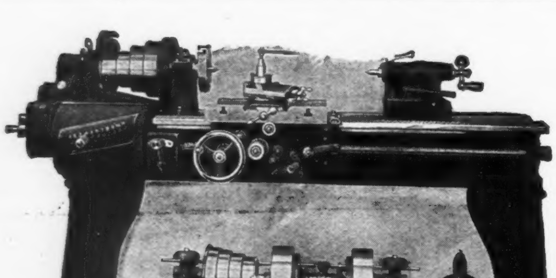


Read Our Specifications

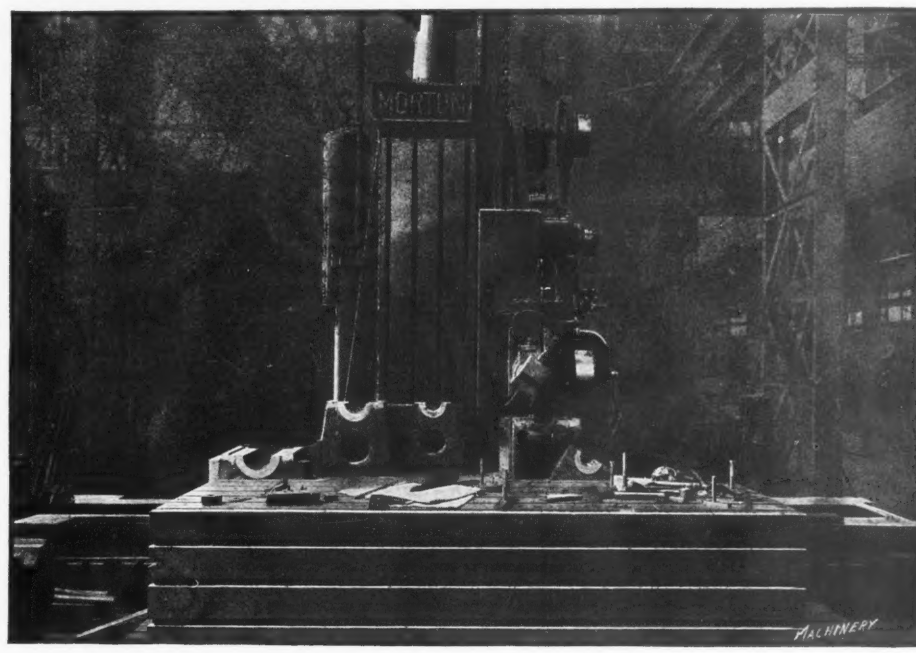
Before going ahead get a copy of our specifications of this 14" engine lathe. It's a

CARROLL-JAMIESON Screw Cutting Lathe

It has double back gears, quick-change gears giving thirty-two changes of feed without removing a gear, nine spindle speeds, 2½" belt drive from three-step cone.

Drop a line now for a set of specifications.

THE CARROLL-JAMIESON MACHINE TOOL CO., 257 Davis St., Batavia, Ohio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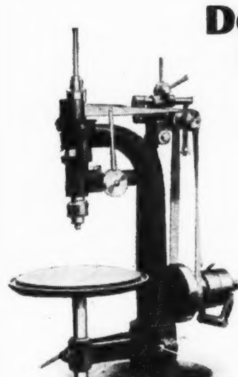

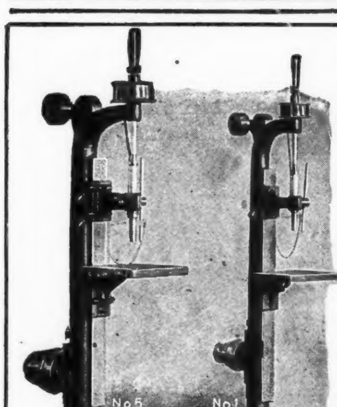
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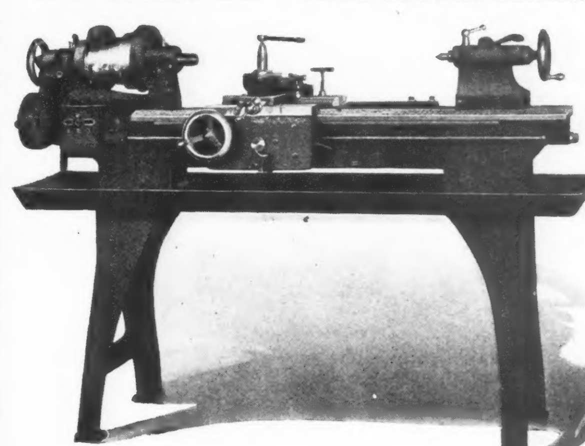
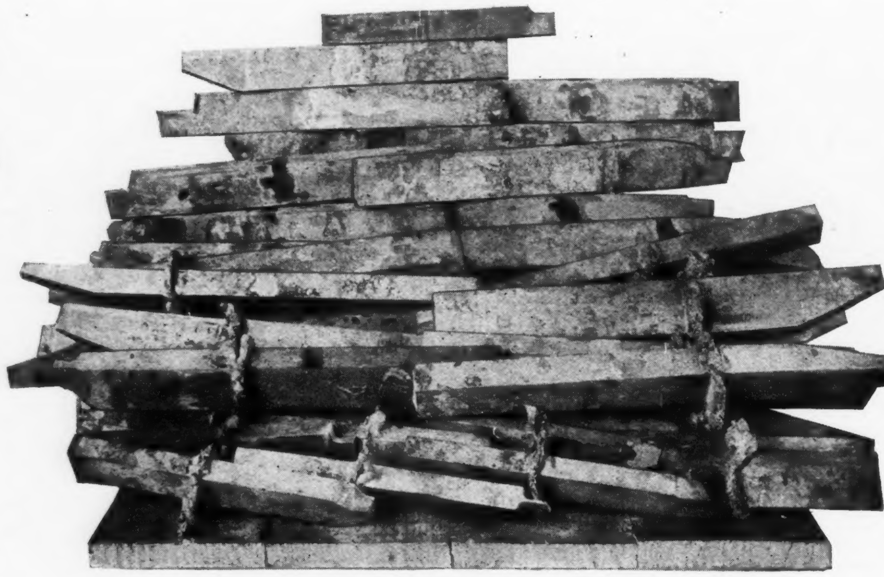
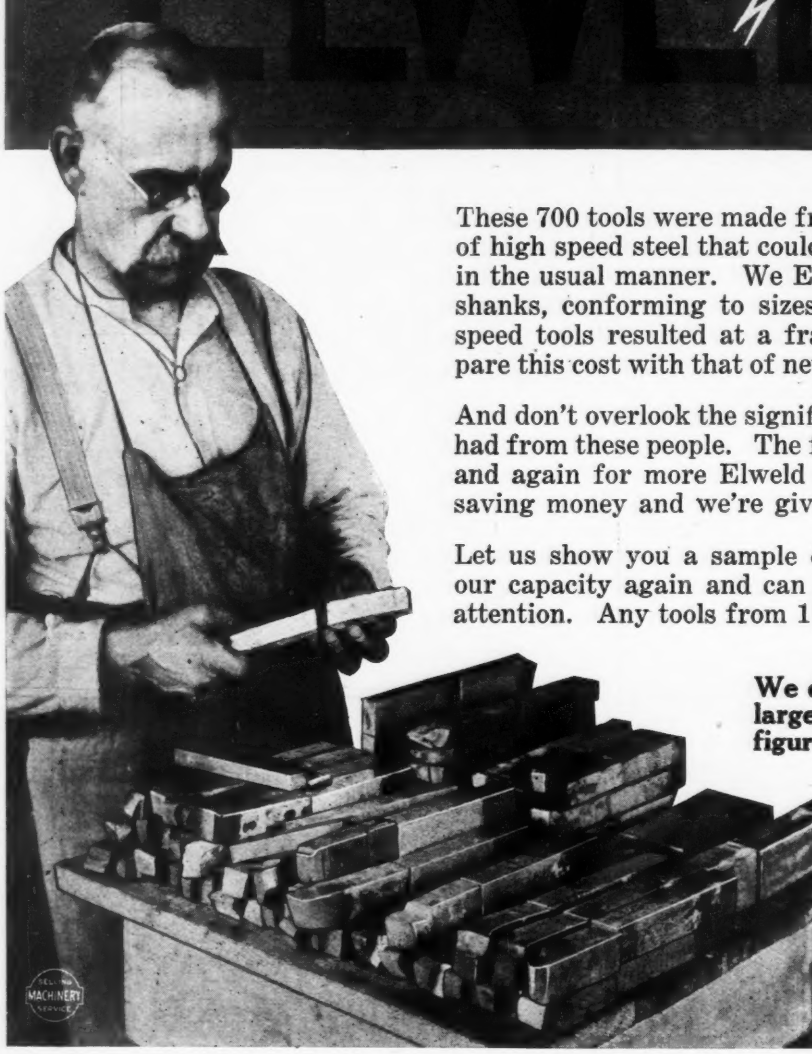


700 ELWELD TOOLS

For One Concern

That Would Indicate They Were Good Tools Wouldn't It?





These 700 tools were made from so-called scrap—short pieces of high speed steel that could no longer be used to advantage in the usual manner. We Elwelded these pieces to tool steel shanks, conforming to sizes designated, and 700 new high speed tools resulted at a fraction of their first cost. Compare this cost with that of new tools and it'll be an eye-opener.

And don't overlook the significance of the repeat orders we've had from these people. The fact that they've come back again and again for more Elweld tools surely proves that they're saving money and we're giving satisfaction.

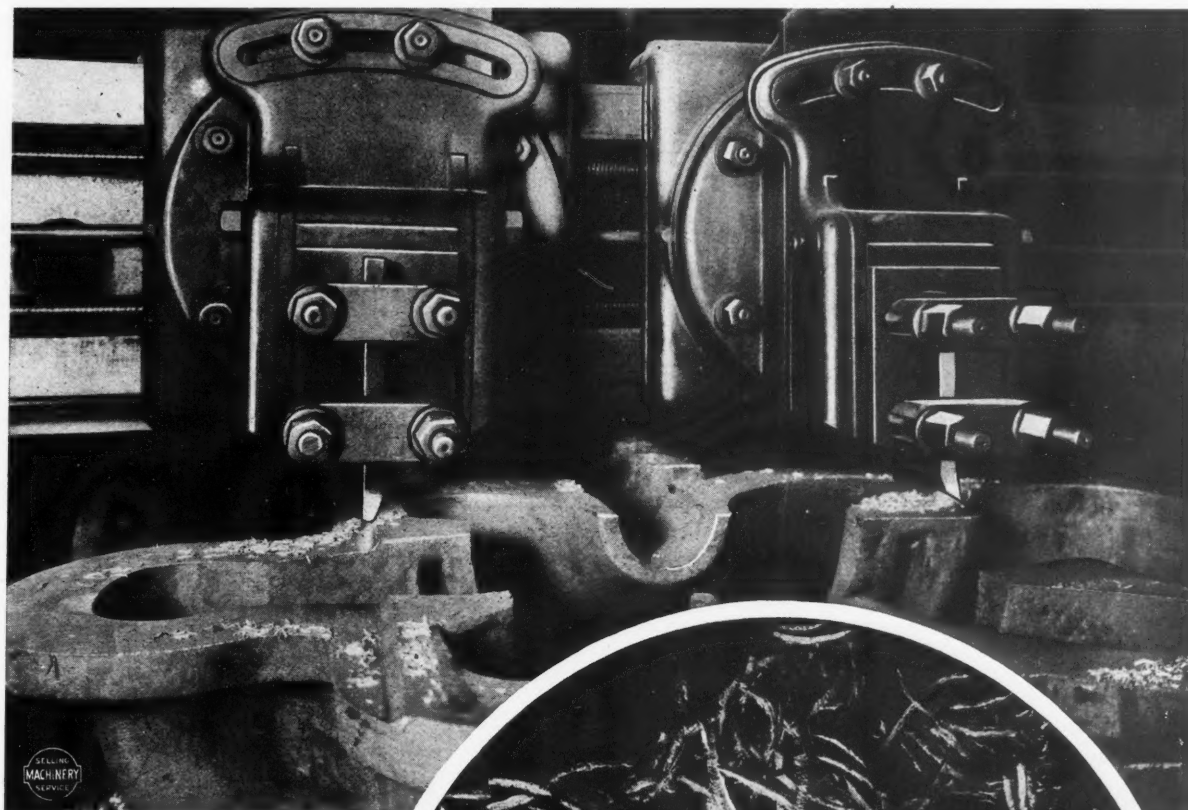
Let us show you a sample of our work. We're increasing our capacity again and can give your specifications prompt attention. Any tools from 1½″ x 2½″ down to ½″ x 1″.

We do commercial butt welding also, large or small, and will be glad to figure with you.

The Electric Welding Co.

(Superior Viaduct)

Cleveland Ohio



These are

High Speed Steel Tools

Would You Believe it?

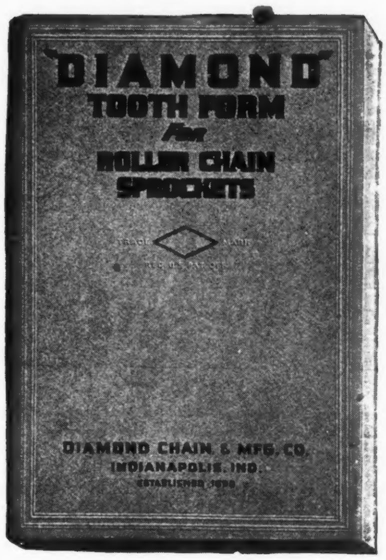
This job is typical of some of the work put up to Uranium tools. These two pump casing castings are made of acid-proof bronze, an exceptionally tough metal to cut; the chips shown are full size and indicate how short the metal flakes under the cutting action. Uranium steel tools are the only tools that stood up under this work.

You, no doubt, often meet just such tough planing or turning propositions and then you need Uranium for best results.

Your own steel man can tell you about Uranium High Speed Steel; if not, consult us

Standard Alloys Company

Forbes & Meyran Avenues **PITTSBURGH, PA.**



A Useful Handbook

If you are interested in efficient power transmission, you will find our new complete catalogue and treatise on chain driving, "Diamond Tooth Form for Roller Chain Sprockets," a most useful handbook.

This booklet contains valuable data regarding the application of chains and sprockets for power transmission and will prove of assistance to engineers and others in the solution of driving problems.

A new form of sprocket tooth has been developed by our engineers, which greatly increases the life and efficiency of both chains and sprockets. A complete description of this new tooth form is included in this booklet.

Chain drives are rapidly gaining in prominence—they afford a compact, powerful, positive method of power transmission. Engineers, designers, officials and others who are in touch with driving problems should have a copy of "Diamond Tooth Form for Roller Chain Sprockets" for reference.

BETTER TRANSMISSIONS

*An Aim—
Not A Claim*

Mail coupon or write for your copy today.

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240 West Georgia Street
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DIAMOND CHAIN & MFG. CO.
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Please send copy of new handbook, "Diamond Tooth Form for Roller Chain Sprockets."

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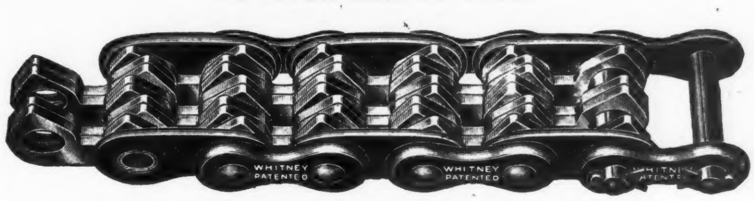
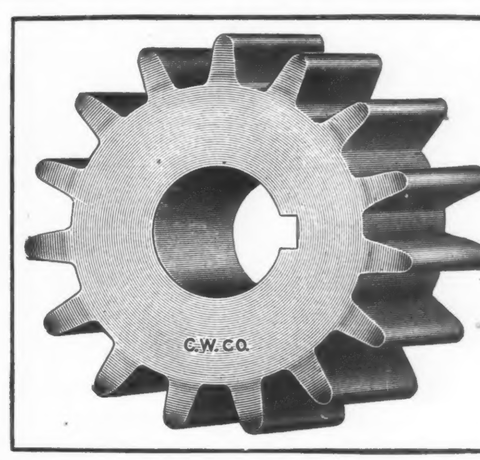
Cullman Sprockets

in stock and to order





For Block, Roller and High Speed Silent Chains. New Catalogue.

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Power Transmitting Machinery

Shafting
Pulleys
Hangers
Floor Stands

Every Power Transmission need is adequately met by the complete line and abundant experience of the

Pillow Blocks
Friction Clutches
Flexible Couplings
Gears for Heavy Service

CRESSON-MORRIS COMPANY
Engineers—Founders—Machinists
PHILADELPHIA PENNA., U. S. A.

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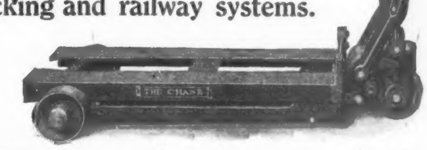
Cuts Handling Costs

Save labor and floor space with Chase direct control, easy running roller bearing trucks.

Complete trucking and railway systems.

Write for catalog No. 16B.



THE CHASE FOUNDRY & MFG. CO., Columbus, Ohio

THE SHAW ELECTRIC CRANE COMPANY

WORKS MUSKEGON, MICHIGAN

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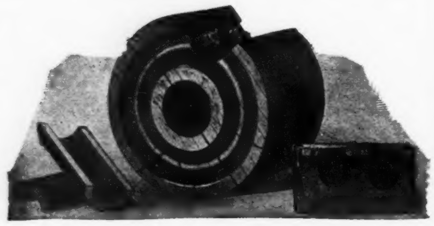
GILBERT PULLEYS

COST LITTLE and SAVE MUCH



Gilbert Wood Split Pulleys cost less than split iron or steel pulleys. Being much lighter, they require less expensive shafting and hangers, put less weight on the bearings, and so reduce power loss through friction.

It has been authoritatively proved that wooden pulleys require nearly 50 per cent less belt tension than iron—for equal power. Reduced tension prolongs belting life and further reduces journal friction and strain on the shafting.

Gilbert Wood Split Pulleys wear as long as iron, give as good or better service, and save money in every way.

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NEED THRUST BEARINGS QUICK?

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We make them—big bearings, good bearings. Balls, all sizes, any material. Speedy delivery on early orders. Write for circulars.

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FREE BOOKLET SHOWING HOW TO SAVE HANDLING EXPENSE

How to enable 1 man to do the work of 4 or 5—how to meet the labor shortage—by using the

BARRETT MULTI-TRUCK

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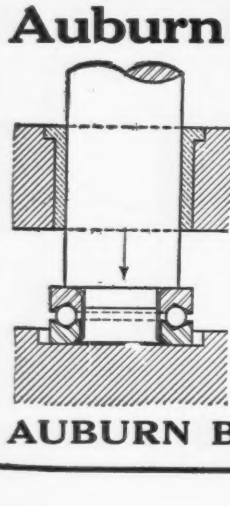
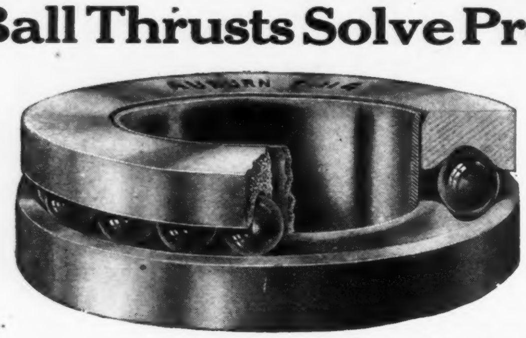
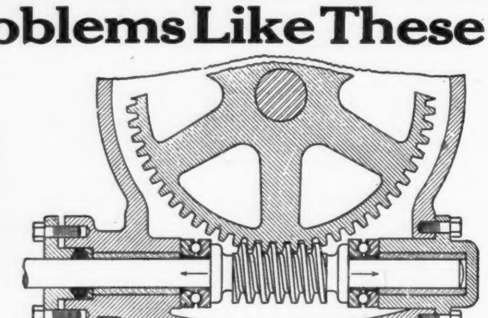
Auburn Ball Thrusts Solve Problems Like These







State your needs or ask for bulletins.

Steel, Brass and Bronze Balls

AUBURN BALL BEARING COMPANY, 33 Elizabeth Street ROCHESTER, N. Y.

Trade Mark


"We Must Stop These Pulley Losses"
Pulley breakdowns—men and machines idle—are all too frequent in some plants. Belt slip and air resistance eat up power. Not enough attention is paid to the selection of pulleys. Perhaps wood and iron pulleys are still being used. Their first cost may be low but their last cost is far higher than
AMERICAN
STEEL SPLIT
PULLEYS
The flat A—braced arms of "American" Pulleys cut the air and save enormously on power. Belt slip is reduced to a minimum. "Americans" are guaranteed to perform double belt duty under all conditions not demanding a special pulley. They are capable of enduring higher speeds than any other standard metal pulley.
FREE BOOK—"Pulley Efficiency" sent on request. Full of money-saving pulley information.
The American Pulley Co.
4208-60 Wissahickon Ave. PHILADELPHIA, PA.
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Speed up with Electric Power

G-E Motors and Control increase production and reduce maintenance.

HERE are some of the ways in which modern industry has been speeded up by putting electric power to work in the right place.

Metal mines have boosted output to meet world-wide demands. Great central power plants in place of small local plants in coal mining areas now supply cheaper electric power per ton output for each mine. All tonnage records have been smashed in the steel industry. Greater automobile output has lowered prices and given better road transportation. More and better cloth has been produced at lower power costs.

The engineering problems solved in putting electric power to work in these and other industries were many and intricate. Production of electrical equipment suited to this work and in quantities required is an important part of this company's service to American industries.

Any problem involving the use of power can be simplified by the application of electricity. The General Electric Company is well equipped to lend valuable assistance in working out such problems and is glad to co-operate with manufacturers and engineers in every possible way.

G-E Motor Drive

GENERAL ELECTRIC COMPANY

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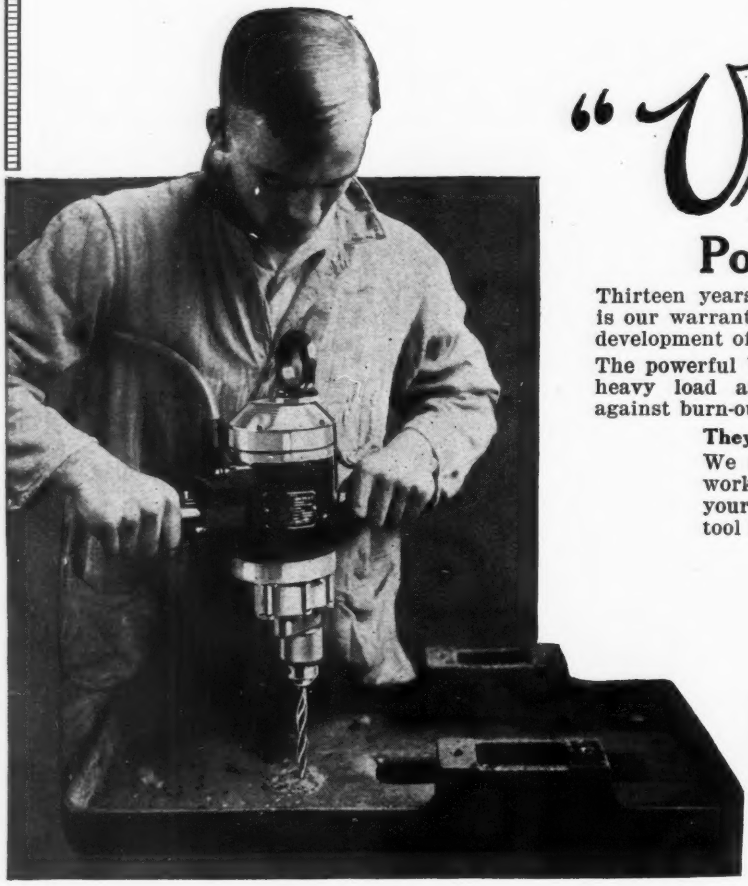

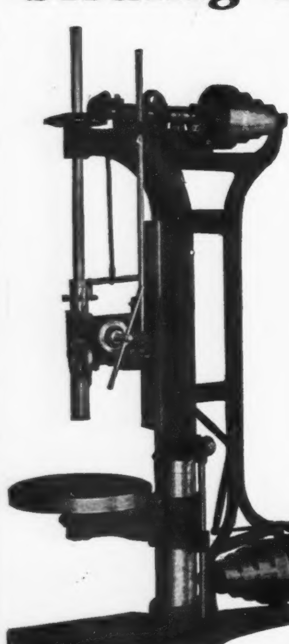

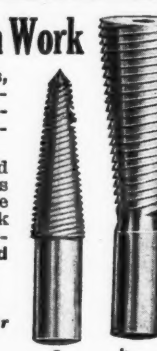
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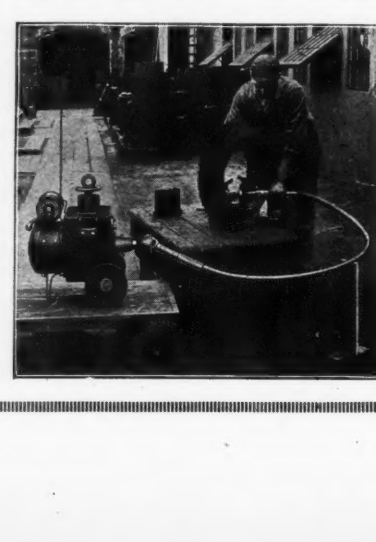


The Pedrick Column Boring Machine Is Needed In Your Shops This Minute

Orders are coming in for this machine in groups — not singly. And as soon as its merits are generally appreciated larger numbers will be wanted.

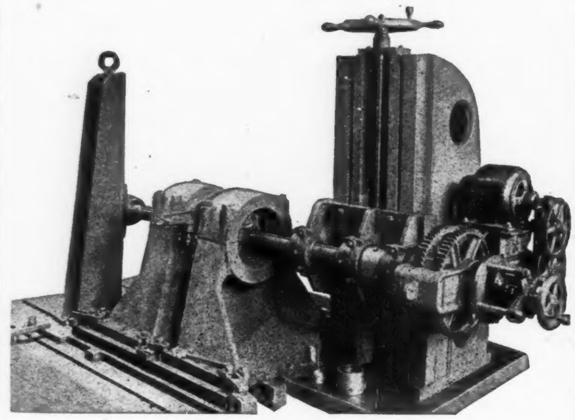
Even a casual inspection will impress these facts:

Simplicity
Range of Work
Power
Moderate Price

The unusual boring capabilities of the machine afford new methods of doing work. The boring bar may be passed through the work with a cutter head traveling along the bar to do the boring, or the bar feeds in the regular manner with the cutter keyed fast or operating auxiliary boring bars. The machine may be set-up in a permanent position or it may be taken to the work.

If you need more boring machines these advantages must appeal to you. We have the machine; it has been tried out and is not an experiment.

Send for your circular now.

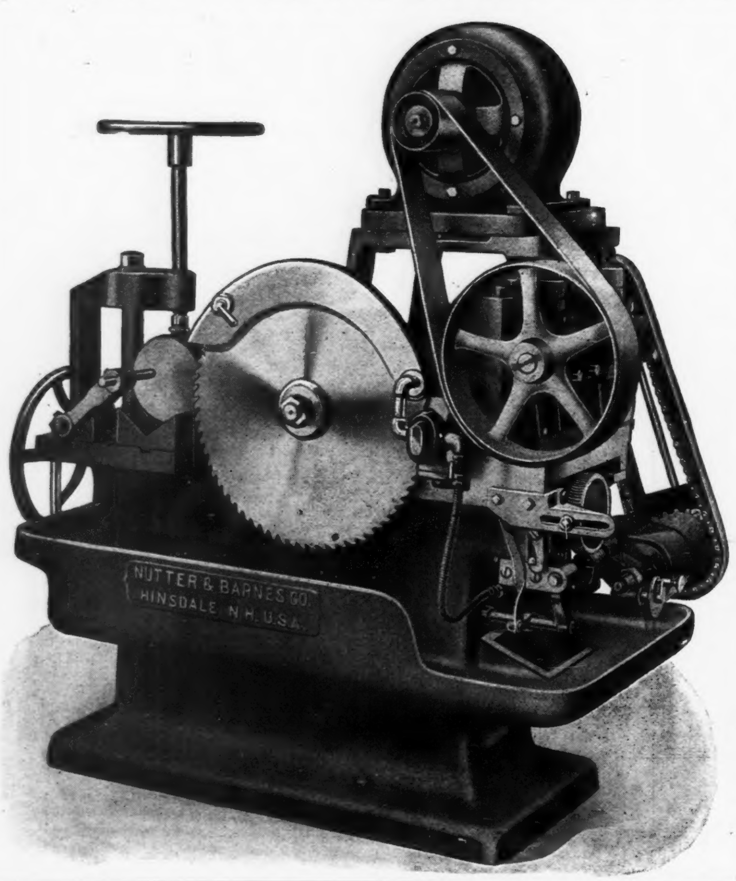


Boring and Facing a Pair of Pedestals

PEDRICK TOOL & MACHINE COMPANY
3639 North Lawrence Street
PHILADELPHIA, PA.

Manufacturers of Portable Cylinder Boring Bars, Crank PinTurners, Pipe Benders, Portable Milling Machines, etc.

Nutter and Barnes Cutting-Off Machines



Massiveness without clumsiness, convenience without superfluous parts, speed, accuracy and range—all combine to put these machines in a distinct class. Size of saw considered, their capacity is greater than any other cutting-off machine; their economy in blades and saw kerf is remarkably high, while their ability to stand hard, driving service is a factor that insures highest returns on the investment.

Complete Details in Catalog.

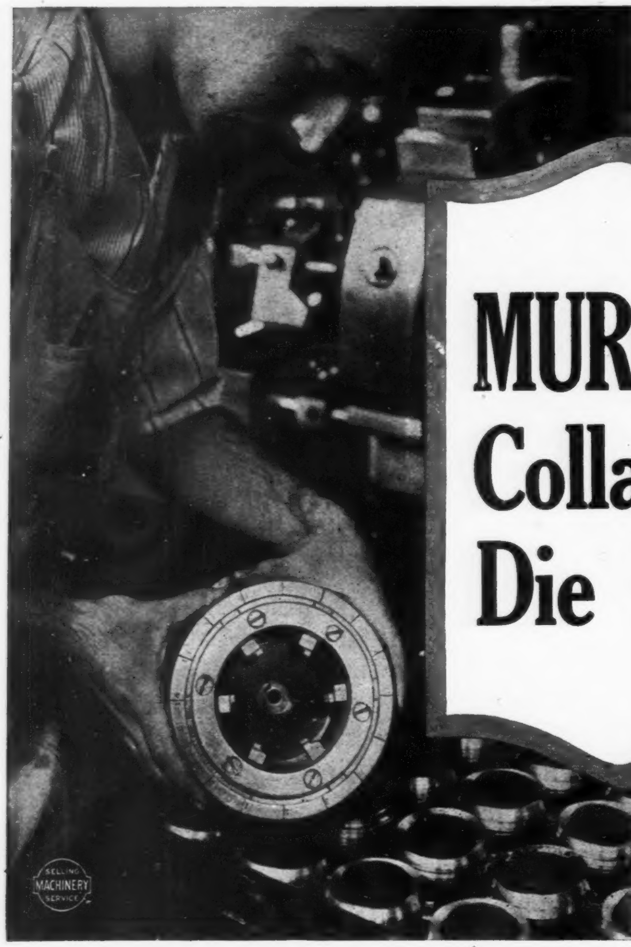
NUTTER & BARNES CO.

The Metal Cutting-Off Machinery Specialists

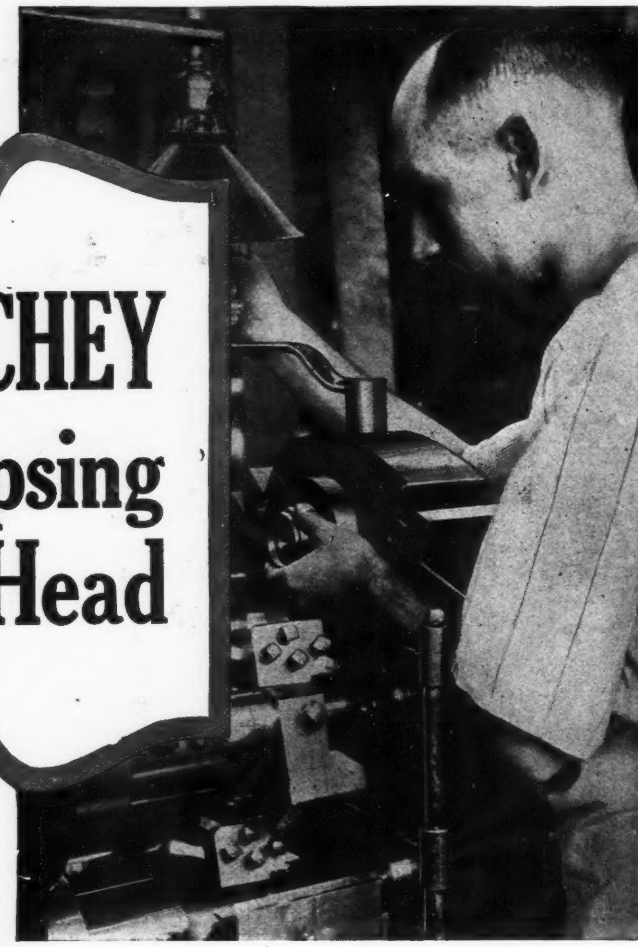
HINSDALE - NEW HAMPSHIRE

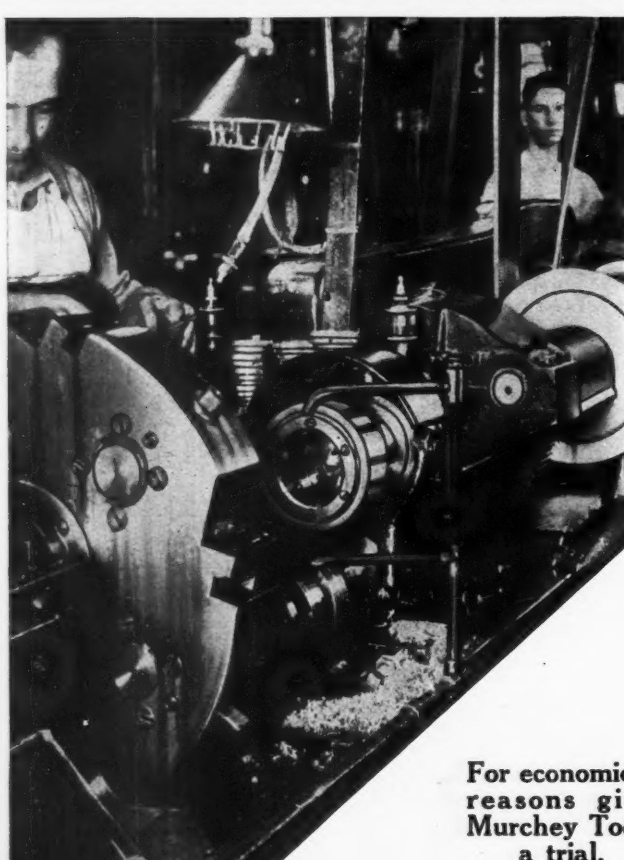
13 South Clinton Street, Chicago

FOREIGN AGENTS: England, Alfred Herbert, Ltd., Coventry, England. Scandinavia, Wilh. Sonesson & Co., Ltd., Malmo, Sweden; Copenhagen, Denmark. Russia, C. Schinz, Petrograd. Allied Machinery Co. of America, 19 Rue de Rocroy, Paris, France; Via XX Settembre 12, Turin, Italy; 16 Seidengasse, Zurich, Switzerland; Ekaterininskaya 6, Petrograd, Russia; Malaya Lubianka 16, Moscow, Russia. Spain, Socieded General de Representaciones, Madrid. Australia, A. Asher Smith, Sydney. South America, A. G. Burbanks, Buenos Aires, A. R. DOMESTIC AGENTS: Swind Mchy. Co., Philadelphia, Pa. Patterson Tool & Supply Co., Dayton, Ohio.



MURCHEY Collapsing Die Head





750 in 10 Hours

These pictures were secured recently from a western manufacturer who has a habit of short-cutting his way to results with the best equipment that can be bought.

They show Murchey Die Heads—12 of 'em—operated on 12 New Britain Automatics, cutting the threads in nose pieces for 3″ shells. Thread is $2\frac{1}{2}''$ diameter, 20 pitch Wentworth, 5 threads to the piece.

The Murchey "Automatic" combination turns out accurately threaded nose pieces at the rate of *750 in 10 hours*, each machine, or *9000 in 10 hours* from the twelve.

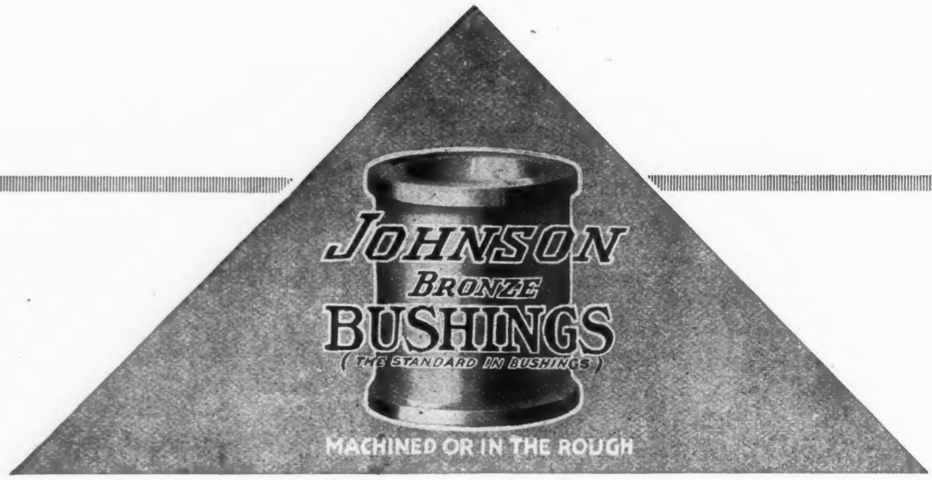
Murchey Tools are high speed thread cutters. Their work is clean cut, accurate, finely finished and economically done. Practically every threading operation can be handled with taps and dies picked from the Murchey stock. If special tools are required we can furnish them in short order.

For economical reasons give Murchey Tools a trial.

MURCHEY MACHINE & TOOL CO.

34 PORTER STREET **DETROIT, MICHIGAN**

Great Britain, Ireland and British Colonies, Coats Machine Tool Company, Limited—LONDON — NEWCASTLE-ON-TYNE — GLASGOW. France: Fenwick Freres & Company, 8 Rue de Rocroy, PARIS.



We have an interesting price and delivery proposition for you on bushings made up to your specifications or in the alloy best suited to your requirements as suggested by our years of specialized bushing experience. Send blueprints for estimates.

BUSHINGS

JOHNSON BRONZE COMPANY

NEW CASTLE, PA.

Sales Offices: New York, Buffalo, Pittsburgh, Cleveland, Cincinnati, Detroit, Chicago, San Francisco.

Bushing Specialists.

What DYSON Knows about Forging

Forging is like a lot of other things; the more you know about it, the better you do it.

There isn't anything Dyson doesn't know about forging; and he knows some things about combining metals and heat treating that nobody else does—it shows in his work.

That's why Dyson forgings are just a little better than any others.

We make any kind of castings, rough machined to your specifications—up to 5 tons. *Write for Estimates.*

JOSEPH DYSON & SONS, Cleveland, Ohio

MOLTRUP

IS NOW MAKING

Round Cold Drawn Steel

for **Shafting, Screw Steel, etc.**

It is made with the same careful precision that characterizes our

HEXAGON, FLAT AND SQUARE COLD DRAWN STEEL SHAPES

Finished Machine Keys — Machine Racks — Flattened Ground Steel Plates and Discs.

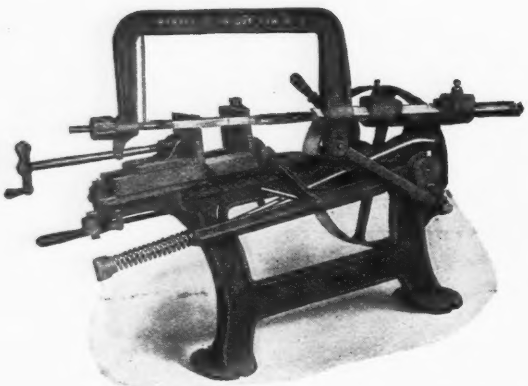
Moltrup Steel Products Co.

BEAVER FALLS PA., U. S. A.

SALES AGENCIES

CHICAGO AND DETROIT....Central Steel & Wire Co.
NEW YORK....George Nash Co.
BOSTON....Edgar T. Ward's Sons
CHESTER....Allison & Company
SAN FRANCISCO....Milton Pray

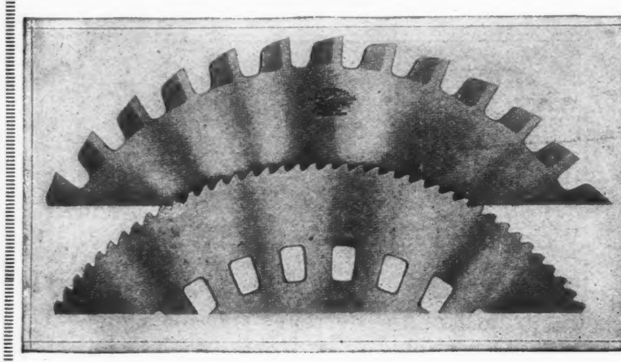
Marvel Draw Cut Hack Saw No. 2



Strong and rigid in construction, accurate, fast and economical in operation. Provided with adjustable stroke, quick-action heavy swivel vise that swivels both ways, automatic stop, means for taking up wear, etc. Capacity on long stroke, 6″ by 6″; on short stroke 8″ by 8″. Blades 12″ to 17″. One of the most profitable machines of its class from every standpoint, and very moderately priced. *Details in catalog.*

Armstrong-Blum Manufacturing Company
343 North Francisco Avenue
CHICAGO ILLINOIS, U. S. A.

ATKINS METAL SAWS



We make them for every purpose—hot or cold cutting, and for all makes of machines.

The economy of their use is worth your investigation.

Write for Metal Saw Treatise "M."

E. C. ATKINS & CO., Inc.

The Silver Steel Saw People.
Home Office and Factory - Indianapolis, Ind.
Canadian Factory - - - - - - - Hamilton, Ont.
Machine Knife Factory - - - Lancaster, N. Y.

Branches carrying complete stocks in all large distributing centers, as follows:

Atlanta, Chicago, Memphis, Minneapolis, New Orleans, New York City, Portland, Ore. San Francisco, Seattle, Vancouver, B.C. Sydney, N. S. W. Paris, France.

The HIGLEY

COLD METAL SAW

Catalog furnished by

Vandyck Churchill Co.
New York Philadelphia Pittsburgh New Haven

SHAPERS

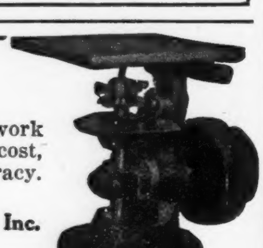
EXCLUSIVELY

12″ to 32″ Stroke

SMITH & MILLS CO.
CINCINNATI, OHIO, U. S. A.

FOREIGN AGENTS: C. W. Burton, Griffiths & Co., London. G. & F. Limbourg Freres, Brussels. Van Rietschoten & Houwens, Rotterdam. Glaenzer, Perreaud & Thomine, Paris. Stussi & Zweifel, Milan.

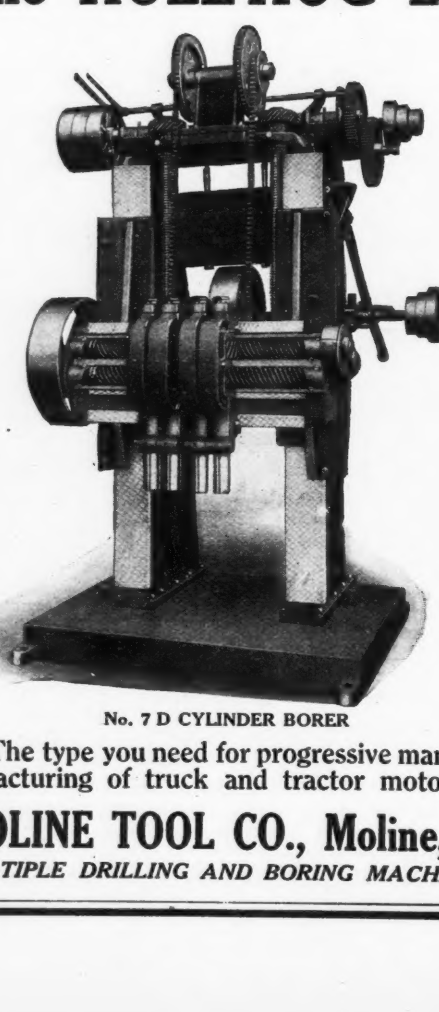
A "HARTFORD" Die Filing Machine



accomplishes many times more work than hand filing, at the same labor cost, and does it with greatest accuracy. More details on request.

THE ROBINSON TOOL WORKS, Inc.
Waterbury, Conn., U. S. A.

The "HOLE HOG" Line

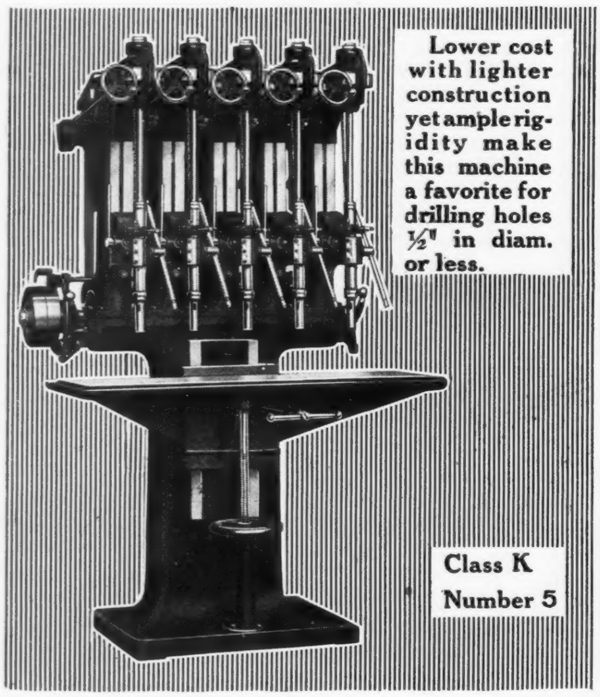


No. 7 D CYLINDER BORER

The type you need for progressive manufacturing of truck and tractor motors.

MOLINE TOOL CO., Moline, Ill.
MULTIPLE DRILLING AND BORING MACHINERY

HENRY & WRIGHT
Drilling Machines



The Henry & Wright Mfg. Co.
Hartford, Conn.

ITS TRADE A MARK SIPP

FEATURES

Quick Change Speed
Change in 2 seconds

Most Efficient Drive
No belt troubles

Safety First
All parts protected

Heaviest Drill Made
Yet very sensitive

All Ball Bearings

The Right Speed

You get accuracy and bigger output with

The Sipp Quick-Change-Speed Drill

because the speed can be changed in two seconds, hence the right speed for the job will naturally be used. *Write for Bulletin No. 4.*

THE SIPP MACHINE CO., Paterson, N. J.

"Accuracy First"

and the

TURNER TURRET

In one of the big shops at Greenfield, Mass., precision drilling, reaming, tapping, etc., are handled on the Turner Turret in a manner that satisfies the demand for accuracy and throws in speed for good measure. On the Turner Turret illustrated the operator is drilling die heads, one hole two diameters, one of which is also reamed. The three tools are indexed automatically, completing the operations and putting through the entire lot in remarkably fast time.

The Turner Turret saves 30 to 60 per cent of time and economizes labor—therefore reduces costs. And it's a mighty wide range machine.

Write for Complete Catalog

Turner Machine Company
DANBURY, CONN. and NEWARK, N. J., U. S. A.
Incorporated with Turner, Atherton & Co., Ltd.
Denton, Manchester and Stockport, England.

THE LINDGREN
13-Inch High Speed Drill

All bearings are bronze bushed and provided with ring oilers. The spindle has ball thrust bearings. The sleeve is graduated in inches.

New lubrication features
No leakage of oil

F. W. LINDGREN CO.
ROCKFORD ILLINOIS, U. S. A.

Radial Drills, High Speed Sensitive and Plain Radial Drills

Manufactured in sizes 2½, 3, 3½ and 4 foot by

THE CARLTON MACHINE TOOL CO.
Successors to
The William E. Gang Company, Cincinnati, Ohio

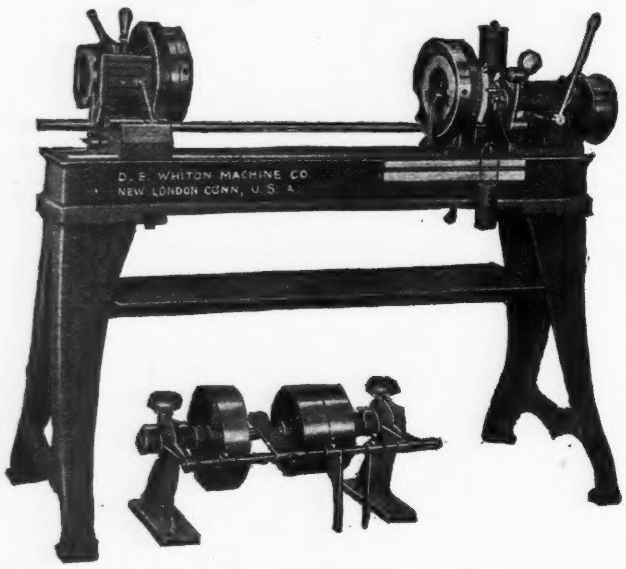
JOHNSON 14" SENSITIVE DRILL

A most practical machine for the purpose for which it was built—to drill 9/16" holes and under with speed and accuracy that make for greatest efficiency. The "Johnson" spindle and the other features of construction will interest you. Ask for details.

Johnson Machine Tool Co., Gouverneur, N.Y.

THE WHITON
REVOLVING CENTERING MACHINE

FOR ACCURATELY CENTERING FINISHED SHAFTS

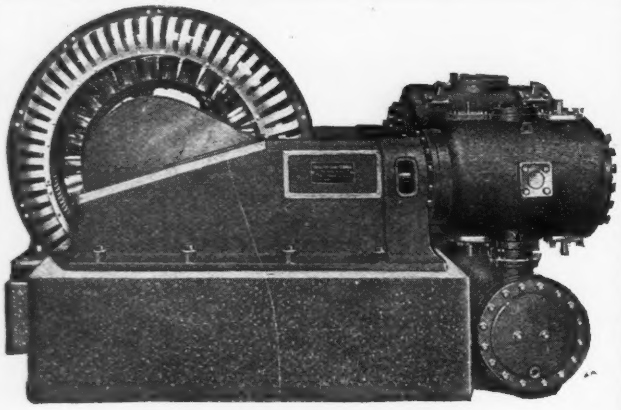


The cut shows new **Revolving Centering Machine**—a large size of the well-known machine of this type. It is heavier throughout and has capacity to center shafts up to 5 inches in diameter.

Constructed same as the smaller machine and embodies all the special features.

Circulars and prices sent upon application.

THE D. E. WHITON MACHINE COMPANY
NEW LONDON, CONNECTICUT, U.S.A.



LAIDLAW
Feather Valve
COMPRESSORS
For Operating Air Drills and Pneumatic Tools

Include features which greatly increase the return on your compressor investment.

Laidlaw Feather Valve Air Compressors have established notable records for low operating costs.

Described in detail in Bulletin L530. Write for a copy.

WORTHINGTON PUMP AND MACHINERY CORPORATION

115 Broadway
New York

Laidlaw Works:
Cincinnati, Ohio

Branch Offices in All Principal Cities L 238.2

MERRELL
Pipe Threading and Cutting Machinery.

Hand or Power Operated

THE MERRELL MFG. CO.
15 CURTIS STREET TOLEDO, OHIO

ARMSTRONG

Genuine Stocks and Dies

Pipe Threading and Cutting-Off Machines

Our dies can be adjusted to the variations in the size of fittings. They can be worked with less labor and the desired result accomplished in less time than with other dies. They are interchangeable in the stock, sharpened without drawing the temper, easily adjusted and kept in condition. Page 29 of our catalog gives you the details regarding our Pipe Threading and Cutting-off Machines. Sent on request.

THE ARMSTRONG MFG. CO.
297 Knowlton Street BRIDGEPORT, CONN.

THE SAUNDERS—

for Quick and Accurate Pipe Threading and Cutting

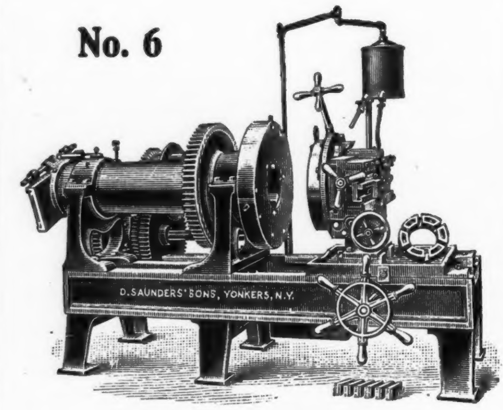
Saunders No. 6 is built for business and embodies every facility for quick and accurate service.

Special gearing gives ample power, without large pulleys and tight belts. Cone pulleys and interchangeable gearing—controlled by lever—vary speeds according to sizes to be cut. The adjustable die head—our patent—with interchangeable chasers, threads from 2½ to 8 inches and releases pipe without stopping or reversing the spindle. There are no complicated attachments—the whole mechanism is direct and easy to operate.

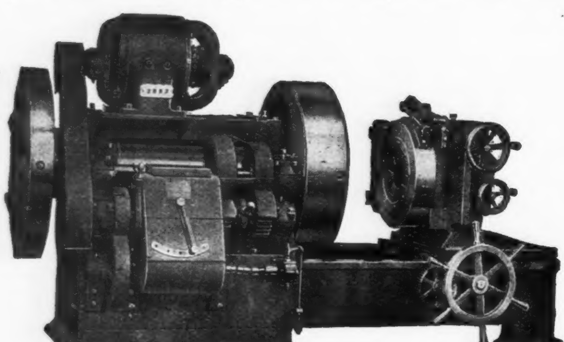
Complete Description in Catalog "P."

D. SAUNDERS' SONS, Yonkers, New York

No. 6



The Method of Drive is an Important Thing in a Pipe Machine



Because a lot of time is wasted if the speed is not just right for every size and material of pipe.

The "Stoever" Pipe Machine

has a single-pulley drive with gear speed variation. This means that **the belt speed is constant,** not lowest when it should be highest. **The belt tension is always proportional to the power transmitted**—economy of power. **The belt contact is constant and always adequate.**

The "Stoever" has a friction countershaft which eliminates shifting belts and saves at least one-third in belting cost.

The gear speed variation affords a speed exactly right for every size of pipe, and for iron or steel. **This means maximum cutting and threading speed.**

Write for the "Economy" Booklets.

TREADWELL ENGINEERING CO.

Sales Office: 140 Cedar Street, New York

Works: Easton, Pa.

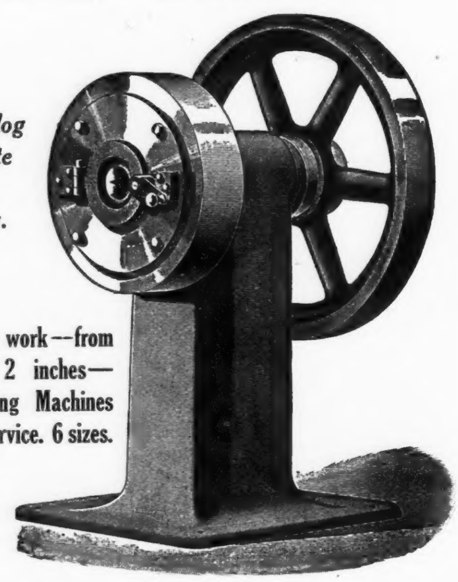
TE 1v

SAVE METAL—

Swage Your Rods and Tubes

Perhaps you have never considered the amount of metal wasted cutting and grinding stock to form. Swaging eliminates this waste and is a process which actually makes the metal stronger and more durable.

Our Catalog is Complete and Interesting.



For all small work—from .015 up to 2 inches—Dayton Swaging Machines give the best service. 6 sizes.

THE EXCELSIOR NEEDLE CO., Torrington, Conn.

Coventry Swaging Co., Ltd., White Friars Lane, Coventry, England, Agents for Great Britain. Fenwick Freres & Co., 8 Rue de Rocroy, Paris, France, Agents for France, Italy, Belgium, Spain, Portugal and Switzerland.

The "Forbes" for Better Thread Cutting

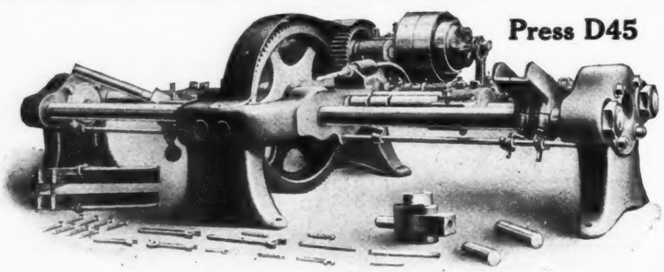
Every user of "Forbes" Machines is firmly convinced that they handle pipe cutting and threading easier, quicker and more accurately than any similar machine. The "Forbes" doesn't have a lot of extra parts; it is complete in itself, can be moved readily from one place to another, has interchangeable parts and adjustments for wear. By reason of these advantages and the exclusive "Forbes" feature of revolving the dies instead of the pipe, one man can easily cut off and thread pipe up to 15" in diameter.

Full line of "Forbes" machines in catalog.

THE CURTIS & CURTIS COMPANY

8 GARDEN STREET BRIDGEPORT, CONN.

FERRACUTE PRESSES



For cutting, forming and drawing sheet metals
Hundreds of sizes and styles for every kind of work

Press D45 is a horizontal, double-ended screw press designed for deepening or redrawing sheet metal tubes and shells from 1 to 6 inches diameter and 18 inches deep. By using the automatically swinging punch, shown at the left, a depth of 24 inches is obtained. Five-inch steel rods take the tensile stresses. The steel screw is 6½ inches diameter. Adjustable gravity-feed, let-off device. Weight about 16,000 lb.

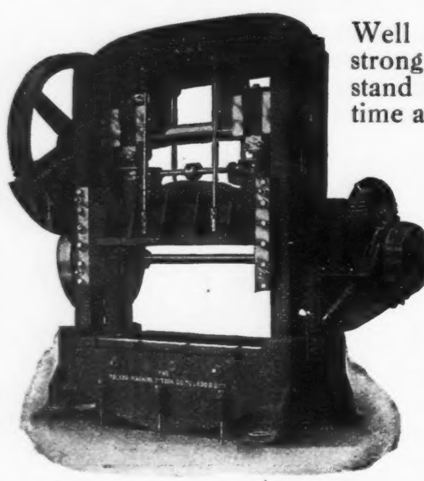
Photographs and full information for the asking.

FERRACUTE MACHINE COMPANY, BRIDGETON, NEW JERSEY, U. S. A.

Conspicuous and Compelling in Their Superiority

THE "TOLEDO"

Double Crank Presses represent the cumulative knowledge of the Toledo organization



"Toledo" No. 95 E for forming and other operations on auto hoods, engine pans, bodies and seats, steel range and other heavy stamped and formed parts.

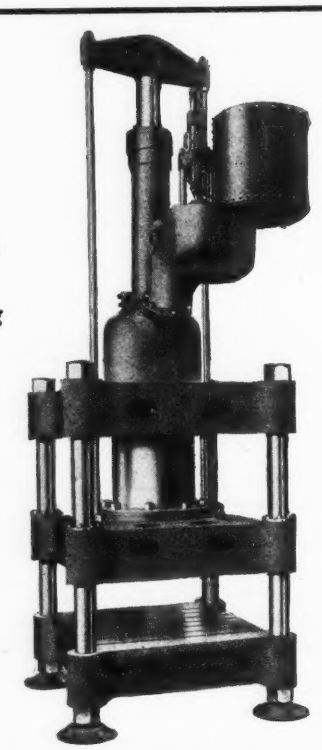
Well proportioned, strong and rigid, they stand the acid test of time and service.

Hammer forged shafts, machine cut gearing well protected, massive connections heavily reinforced, long and wide slides of improved design and other dominant Toledo characteristics.

Over 250 sizes for every requirement of sheet metal and drop forged work.

The Toledo Machine & Tool Co.
TOLEDO, OHIO, U. S. A.

200-500 Ton Flanging Press

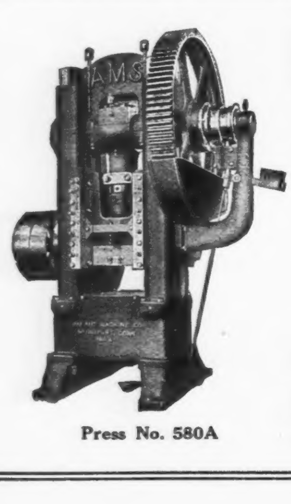


BETHLEHEM STEEL COMPANY

MACHINERY DEPARTMENT

ENGINEERS AND MACHINERY BUILDERS

SOUTH BETHLEHEM, PENNA.



Press No. 580A

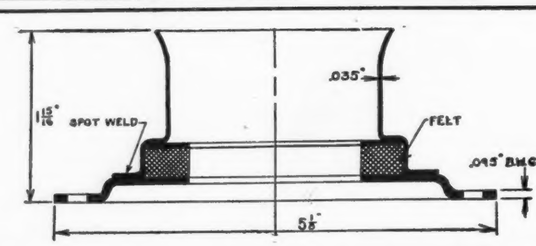
PRESSES

LARGE OR SMALL
REGULAR OR SPECIAL

"AMS"

Let us quote you on your next press

THE MAX AMS MACHINE CO.
BRIDGEPORT CONN.



Have You Ever Considered

That you might save money on some of the parts you use if you bought stampings instead of castings? You can, providing Acklin does the stamping. And you'll find, in addition, that Acklin Stampings are stronger and of greater uniformity.

Trial Order Brings Proof

THE ACKLIN STAMPING CO., 1657 DORR ST. TOLEDO, OHIO

Oxy-Acetylene Welding and Cutting

Conserve Iron and Steel —Cut Out the Scrap Pile

In ordinary times scrap pile waste costs American business millions of dollars annually.

Today, conservation is a matter of national necessity. It is imperative that you help to stop this waste.

Analyze your scrap pile. You'll probably find conditions such as our research men are finding in many industries.

In mine scrap piles were found a year's supply of valuable tram buckets, month's supply of tungsten steel tools, stamp stems and other materials—all easily made good as new at trifling cost by oxy-acetylene welding.

One railway shop saved the tie-up of a hundred locomotives by welding boiler tubes taken from the scrap pile.

There are thousands of other instances where oxy-acetylene welding has made wonderful savings from discarded parts and materials.

As a production process in manufacturing war munitions, railway supplies, boilers, ships, agricultural implements, surgical instruments, etc., oxy-acetylene welding is saving time and materials—giving increased strength, simplicity and neatness to the product.

Prest-O-Lite
PROCESS

Employs both gases (acetylene and oxygen) in portable cylinders. Prest-O-Lite Dissolved Acetylene (ready-made carbide gas) is backed by Prest-O-Lite Service, which insures prompt exchange of full cylinders for empty ones. Provides dry, purified gas, insuring better welds, quicker work, and lower cost, and also avoids the large initial outlay and heavy depreciation incurred in making crude acetylene in a carbide generator.

Necessary equipment is not expensive. We furnish high-grade welding apparatus for $75 (Canada $100); acetylene service at additional cost. Adaptable for oxy-acetylene cutting by the addition of special cutting blow pipe. Thorough instructions are furnished free to every user of Prest-O-Lite Dissolved Acetylene—any average workman who understands metals can learn the process quickly and easily.

Let us help you analyze YOUR scrap pile. Hundreds of possible savings are described in our illustrated literature—many of them directly applicable to your problems.

Write for it today.

The Prest-O-Lite Co., Inc.

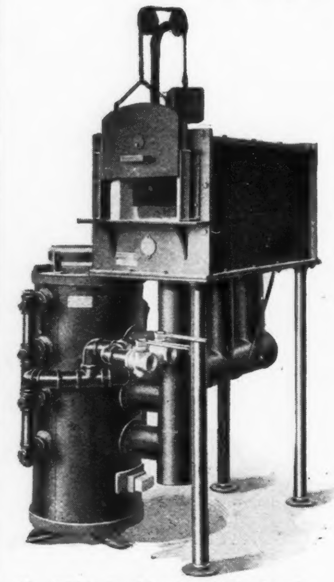
U. S. Main Office & Factory, 837 Speedway, Indianapolis
Canadian General Office, Dept. A.6, Toronto, Ont.

59 Branches and Charging Plants

World's Largest Makers of Dissolved Acetylene

Bellevue Industrial Furnace Co.

Detroit, Michigan



No. 1014—Combination High Speed with Preheating Furnace High Speed. Chamber, 36" deep, 7" diameter. Preheating Oven 11" wide, 36" deep, 10" high, heating from the exhaust of High Speed Furnace.

Manufacturers of

STEEL TREATING FURNACES

FOR ALL PURPOSES

Users Assured High Quality with Large Production.

JULIUS C. HINZ, President

REPRESENTATIVES: Cleveland Tool & Supply Co., Cleveland, Ohio; Coghlin Machinery & Supply Co., Toledo, Ohio; Vonnegut Machinery Co., Indianapolis, Ind.; The Chas. A. Strelinger Co., Detroit, Mich.; Somers, Fitler & Todd Co., Pittsburgh, Pa.; Carpenter & Woodward, 233 Broadway, New York City, N. Y.; The E. A. Kinsey Co., Cincinnati, Ohio.

Years of Service will Wear—But No Strain will Break an Osgood Tool Handle

A steel tube, inserted where the pressure comes, resists all strain and in addition securely locks the tool and ferrule.

Sample FREE to Dealers and Manufacturers. To Others Ten Cents.

J. L. OSGOOD TOOL COMPANY

43-45 Pearl Street **Buffalo, N. Y.**

PHOENIX DIE CASTINGS

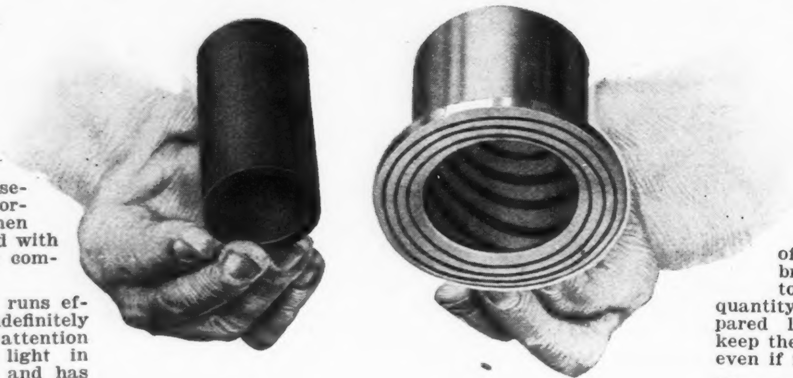
Finished Die Castings of high quality, good workmanship and perfectly compounded alloys. Let us send booklet and more details.

PHOENIX DIE CASTING CO.

21 Illinois Street

BUFFALO, NEW YORK

There Are Two Different Kinds of Genuine Graphited Oil-Less Bushings



NIGRUM

(Impregnated Hard Wood) Oil-Less Bushings are made of selected hard wood, thoroughly seasoned and then thoroughly impregnated with our special lubricating compound.

This bushing not only runs efficiently and lasts indefinitely without oiling or any attention whatever, but it is light in weight, small in bulk and has the additional advantage of absorbing grit and dust without harm to itself, thus prolonging its own service life as well as that of the shafting.

BOUND BROOK

(Graphite-and-Bronze) Oil-Less Bushings are made of finest phosphor bearing bronze, so constructed as to retain a sufficient quantity of our specially prepared lubricating graphite to keep them lubricated in service, even if neglected.

They are used as an insurance against neglect of machine parts that are inaccessible and therefore difficult or impossible to keep properly lubricated.

Oiling will not hurt these troubleless bushings, but they will give efficient service even if overlooked, and as the life of a machine is no longer than the life of its bushings, the proper installation of BOUND BROOK Bushings gives assurance of long life and increased efficiency.

LEADING MANUFACTURERS throughout the country, as well as the U. S. and foreign governments, have endorsed these bushings by using them in hundreds of different kinds of machinery, from Armored Cars, Battleplanes and Naval Vessels to Mill and Factory Machinery, Windmills, Escalators, Gas Engines, Elevators, Mining Machinery, etc., etc.

TEN MILLION BUSHINGS per annum is the capacity of our plants at Bound Brook and Lincoln, New Jersey, where we have every facility for the manufacture of highest quality bushings in large quantities on short notice. Prompt, dependable deliveries are, therefore, assured.

We should be glad to advise with you concerning your own particular bushing problems

All Genuine Graphited Oil-Less Bushings Have Always Been Made at Bound Brook, U. S. A.

BOUND BROOK OIL-LESS BEARING CO.

Specialists in the manufacture of Oil-Less Bushings for more than a Third of a Century

BOUND BROOK NEW JERSEY

No Power Swallowed Up In CHAPMAN BEARINGS

Every bit of power is directly available for the work, in shops where Chapman Bearings are used on shaft transmission. When we add that the *average* saving of power reported is 20 per cent, you can get an idea how much your friction loss is—aside from the waste of time and oil for upkeep, eliminated along with the friction, if you are not using

CHAPMAN BEARINGS

CHAPMAN BALL BEARINGS

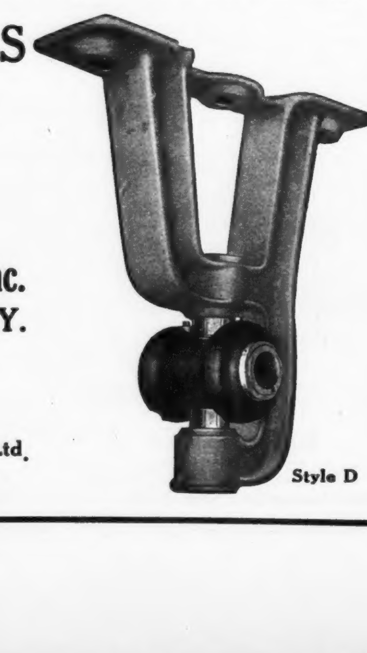
We suggest that you write for our Bulletin No. 106, which explains the why and wherefore of Chapman saving.

TRANSMISSION BALL BEARING CO., Inc.

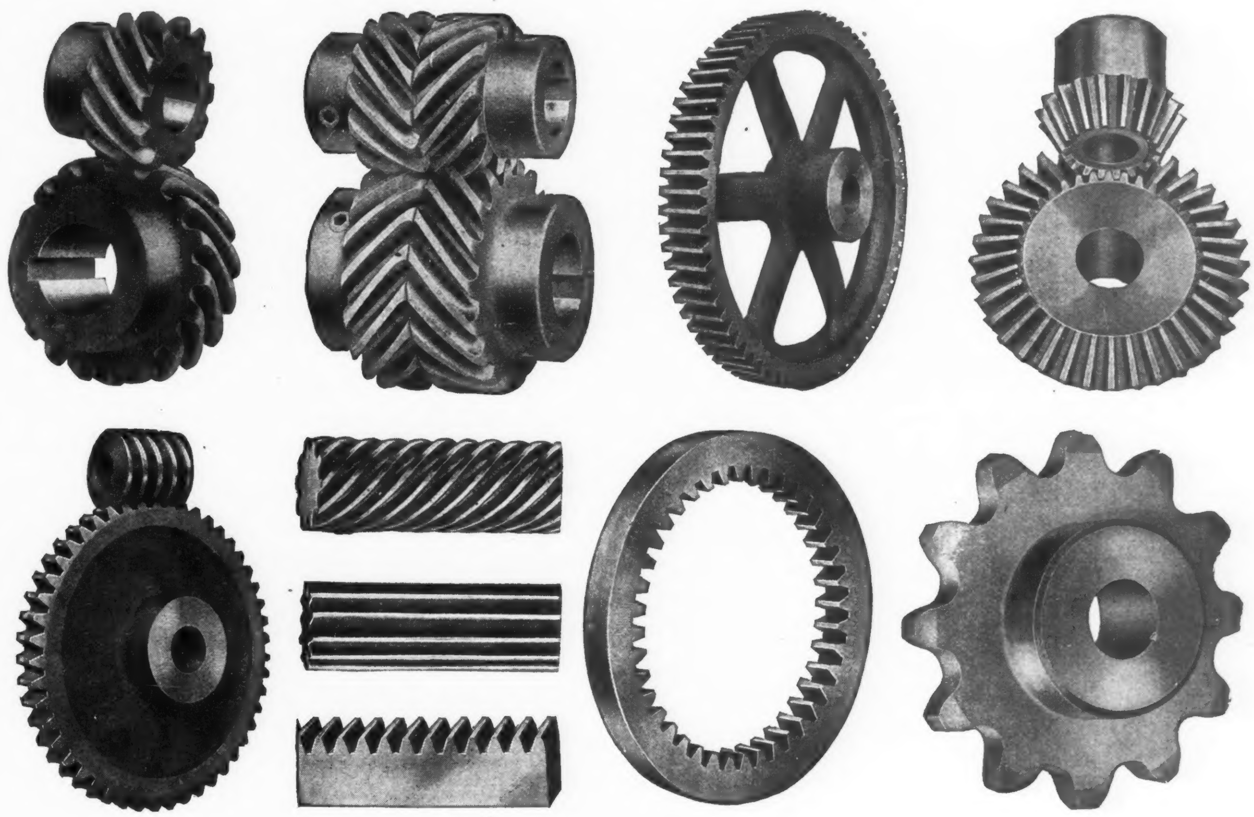
1050 Military Road Buffalo, N. Y.

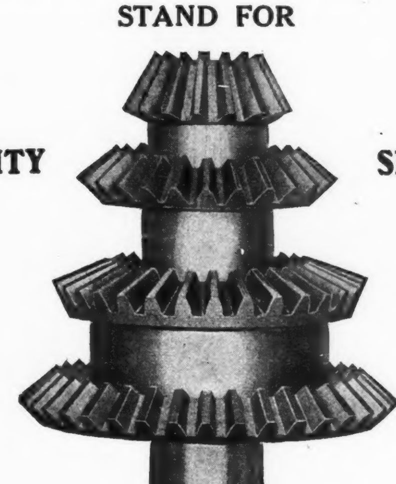
BRANCH OFFICES

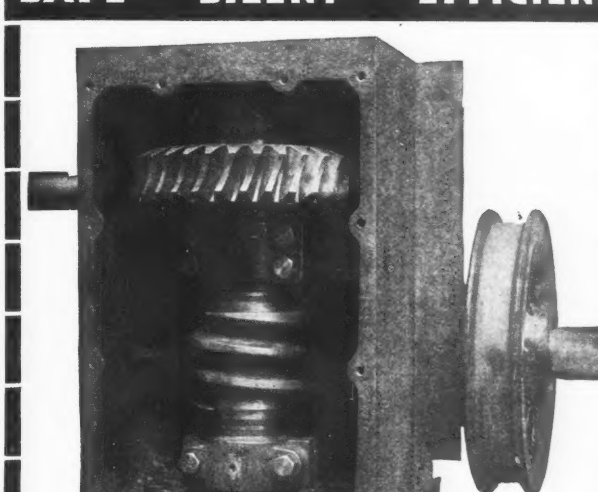
NEW YORK, Room 101, 30 Church Street
PHILADELPHIA, Bourse Building
TORONTO, ONT., Chapman Double Bearing Co., Ltd.
339-351 Sorauren Avenue



Style D







Consider This—

High-speed, motor-driven shears, presses, punches, etc., demand extraordinary service from the gears used with them. Aside from the wear induced by high-speed operation itself, the intermittent work such machines perform—running free one moment and laboring under full load the next—reacts violently and destructively on the gear teeth and unless provided against rapidly leads to wear and in many cases to costly breakage of the gears.

NEW PROCESS NOISELESS PINIONS

used in such service offer an ideal remedy to both these conditions.

Cut from rawhide, especially cured by exclusive process for gear requirements, NEW PROCESS NOISELESS PINIONS have a resiliency in service that metal gears, no matter how well oiled, greased or lubricated, can never acquire. This characteristic resiliency acts as a cushion to absorb the sudden shocks of heavy service and will protect the whole gear train against crystallization and tooth fracture.

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They are cut to suit every motor drive requirement. Ask for our booklet—*Noiseless Gear Driving.* It is worth a thorough reading.

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NEW PROCESS GEAR CORPORATION

SYRACUSE, N.Y.

154

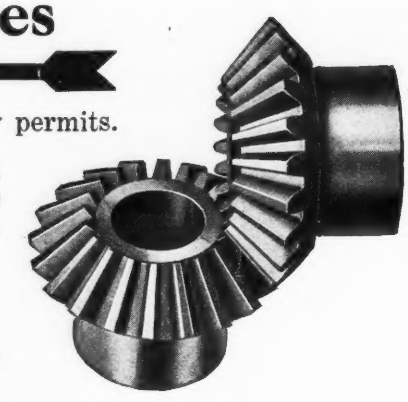
CANADIAN AGENTS: Robert Gardner & Son, Ltd., Montreal, Que.

This Mark Guarantees

gears of the highest grade at prices as low as quality permits.

It also guarantees prompt delivery. We furnish gears for driving all manner of delicate mechanisms, and for hard, heavy service in the industrial field. *We have never lost a customer.* Let us show you why.

Try us also for Automatic Screw Machine products up to 5½″ diameter.



Meisel Press Manufacturing Company
948 Dorchester Avenue BOSTON, MASS., U. S. A.

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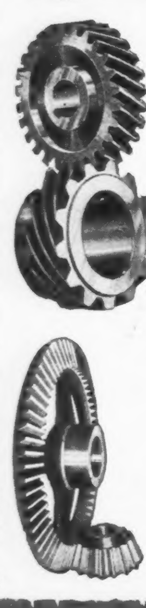
Accurately Generated GEARS



Wherever you find Albaugh-Dover Accurately Generated Gears in use, you are sure to be impressed with their unusual smoothness and silence in operation. Our gears are used by many of America's leading manufacturers of automobiles, trucks, tractors and other machinery. If you use gears—SPIRAL, HELICAL, INTERNAL, WORM OR WORM WHEELS—send us your blueprints or sample gears for estimates. We operate our shops continuously day and night in three shifts of 8 hours each, insuring exceptional service.

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2100 Marshall Blvd. Chicago, Illinois

Forged Gear Blanks

Made from open-hearth steel of any carbon, nickel steel, chrome-nickel steel and chrome vanadium—any size, any amount.

Blanks that will enable you to guarantee, *absolutely*, gear quality in any machine you make. We've been forging gear blanks for a long time and have saved money for concerns the country over. Let us show you what we can do for you.

Send your specifications today.

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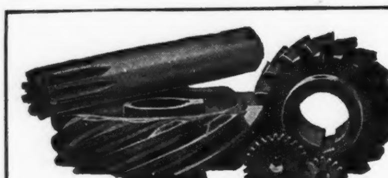

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We guarantee satisfaction

RODNEY DAVIS, Philadelphia, Pa.

ACME GEAR WORKS, Inc.

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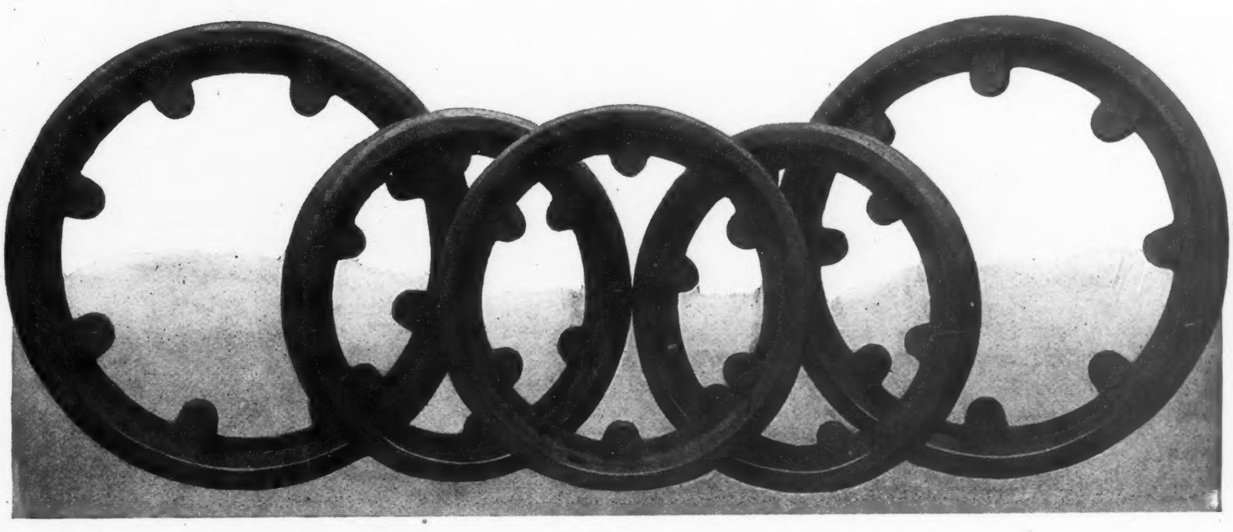

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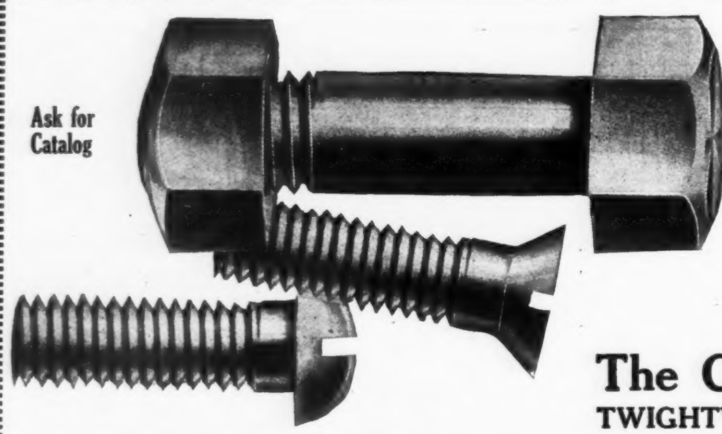

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We make any kind of screw machine product—any metal—any size up to 4 inches in diameter.

We carry in stock a full line of standard screws, studs, bolts and nuts; also a full line of Ford accessories.

We solicit specifications from which we are prompt in furnishing estimates and making deliveries.

All screws U.S.S. thread unless otherwise specified.

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TWIGHTWEE (Cincinnati Suburb) OHIO

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SHIP your high-speed steel scrap to us. We'll grade it; remelt it; forge it to the size bars you need—adding any Tungsten or other material needed to raise it to the high standard of

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High Speed Steel. Every bar trade marked as above; the best high speed steel you ever used.

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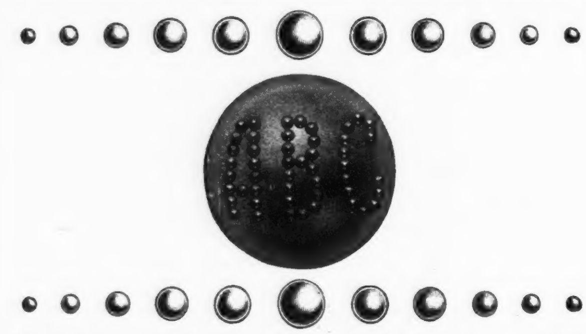

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Elmwood Hartford, Conn.

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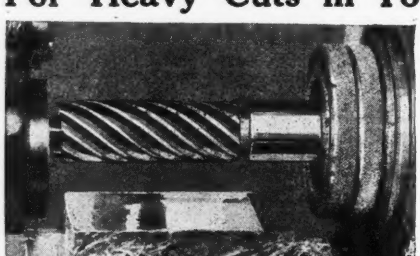

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Windau Tools

The line includes High Speed Spiral Milling Cutters, Form Milling Cutters, Circular Tools and Special Small Tools.

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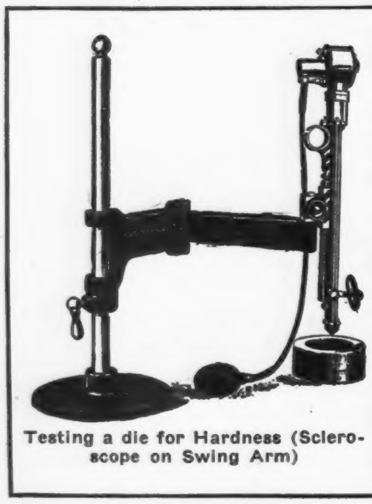

Testing a die for Hardness (Scleroscope on Swing Arm)

Have You a Scleroscope to Test Your Metals?

For Softness, Hardness or Strength

Can be operated by non-technical help. The majority of manufacturers are thus ordering their material to specifications, as to quality and fitness, meaning that the minority who have not a scleroscope to inspect their material may have to accept the discard of their more up-to-date competitors. It shows if you are getting what you pay for out of your tool steels. Send for our 80-page booklet. Free.

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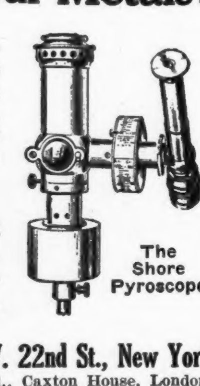
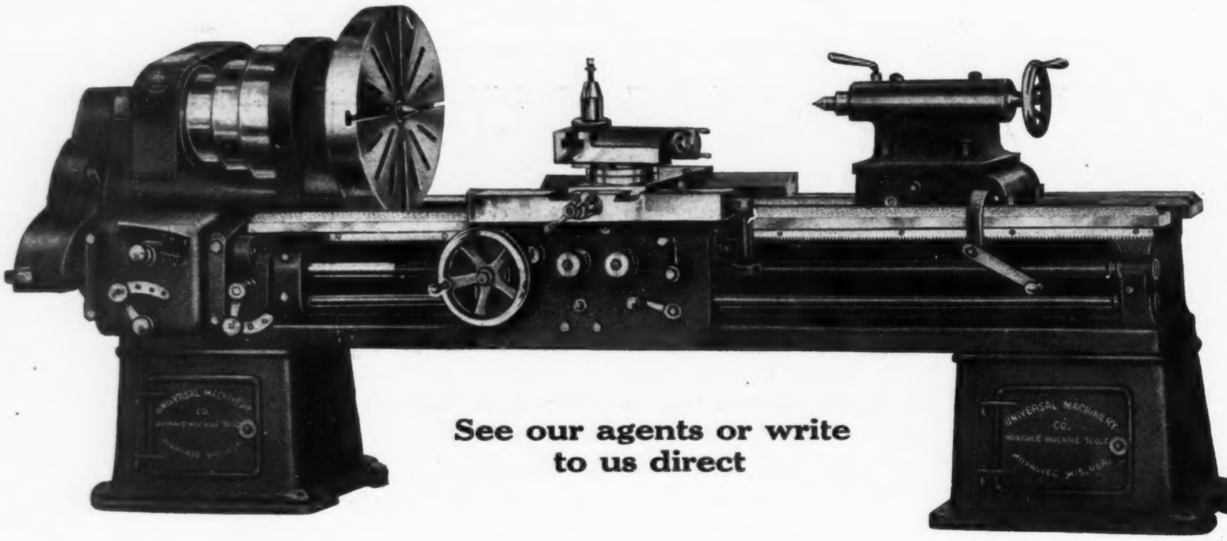
If your heat troubles are still unsolved, investigate the pyroscope, the one common-sense instrument that makes straight for results without fuss. Extreme simplicity—constancy—always ready. Pamphlet on request.



The Shore Pyroscope

SHORE INSTRUMENT & MFG. CO., Inc., 555-557 W. 22nd St., New York

FOREIGN AGENTS: Agent for Great Britain and Colonies, Coats Mch. Tool Co., Ltd., Caxton House, London, S. W.; Glasgow; Newcastle-on-Tyne. Schuchardt & Schutte, Tokyo, Japan. Iznosskoff & Co., Petrograd, Russia. Aux Forges de Vulcain, Paris, France. R. S. Stokvis & Zonen, Ltd., Belgium and Holland.



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Advance Machine Tools

Quality and Good Delivery at a Fair Price

ADVANCE — UNIVERSAL MACHINERY COMPANY — MILWAUKEE, WIS. U.S.A.

Universal Machinery Company

Manufacturers of Advance Machine Tools

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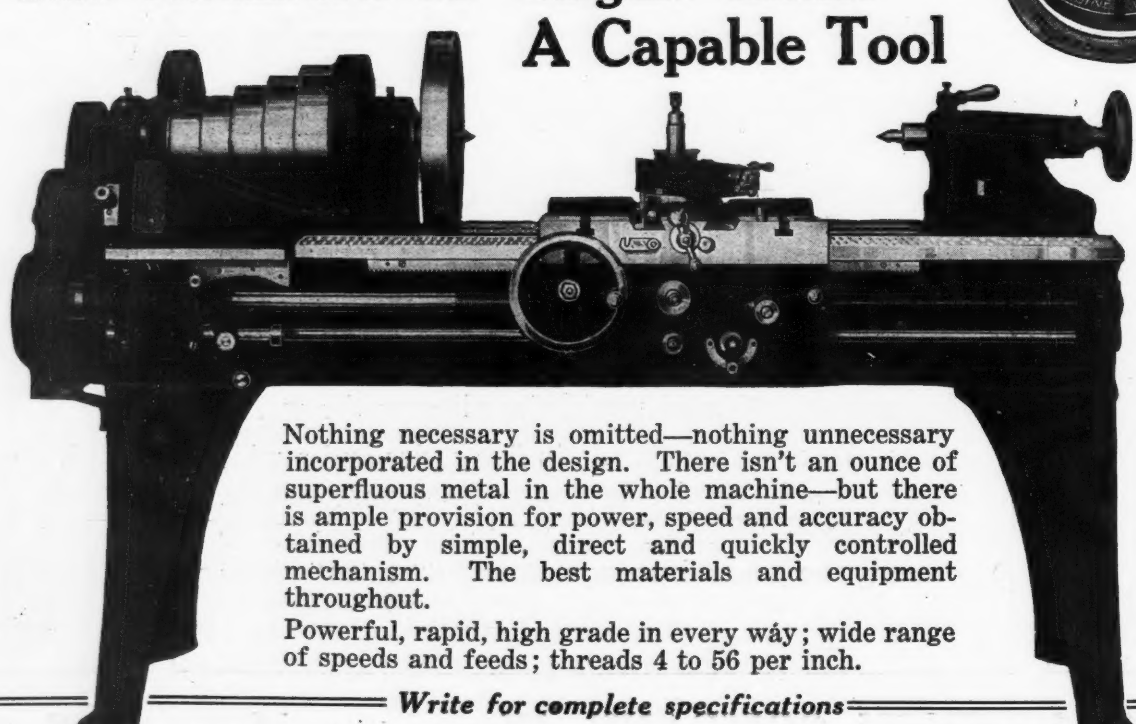
The Rockford 15" Engine Lathe— A Capable Tool

R T

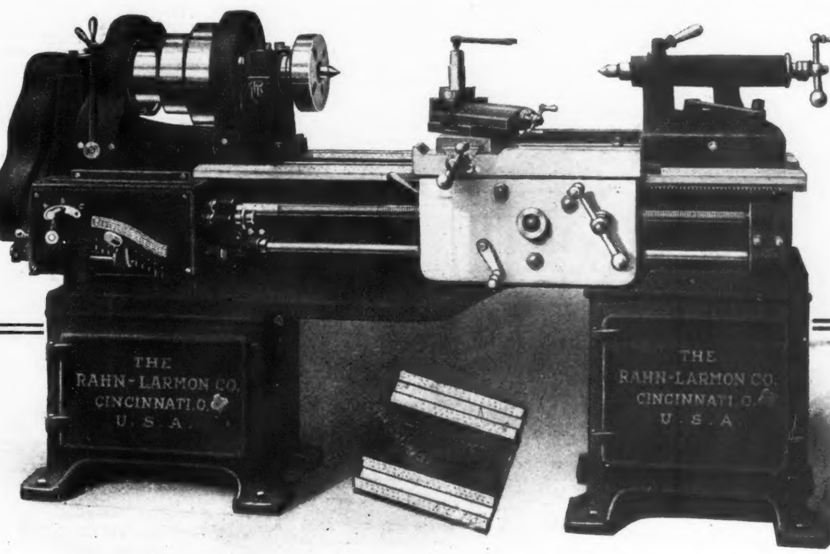


Nothing necessary is omitted—nothing unnecessary incorporated in the design. There isn't an ounce of superfluous metal in the whole machine—but there is ample provision for power, speed and accuracy obtained by simple, direct and quickly controlled mechanism. The best materials and equipment throughout.

Powerful, rapid, high grade in every wáy; wide range of speeds and feeds; threads 4 to 56 per inch.

Write for complete specifications

ROCKFORD TOOL COMPANY, Harrison Avenue and Eleventh St. **Rockford, Illinois**



ATTENTION

GAP LATHES for SHIP YARD WORK

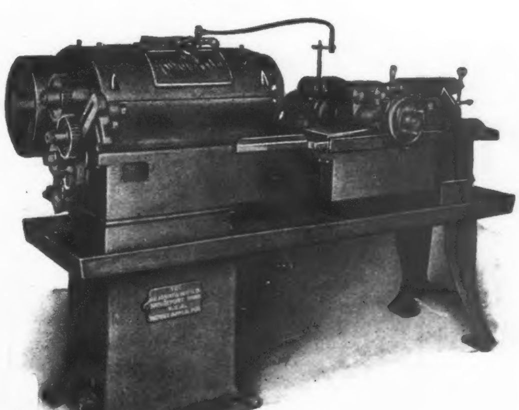
20/26" x 8'

Swings over V's . . .	21 inches
Swings over Gap . . .	27 inches
Width of Gap . . .	14 inches

THREE STEP CONE DOUBLE BACK GEAR QUICK CHANGE GEAR

THE RAHN-LARMON COMPANY, Cincinnati, Ohio, U. S. A.

What Threads or Worms Do You Cut?



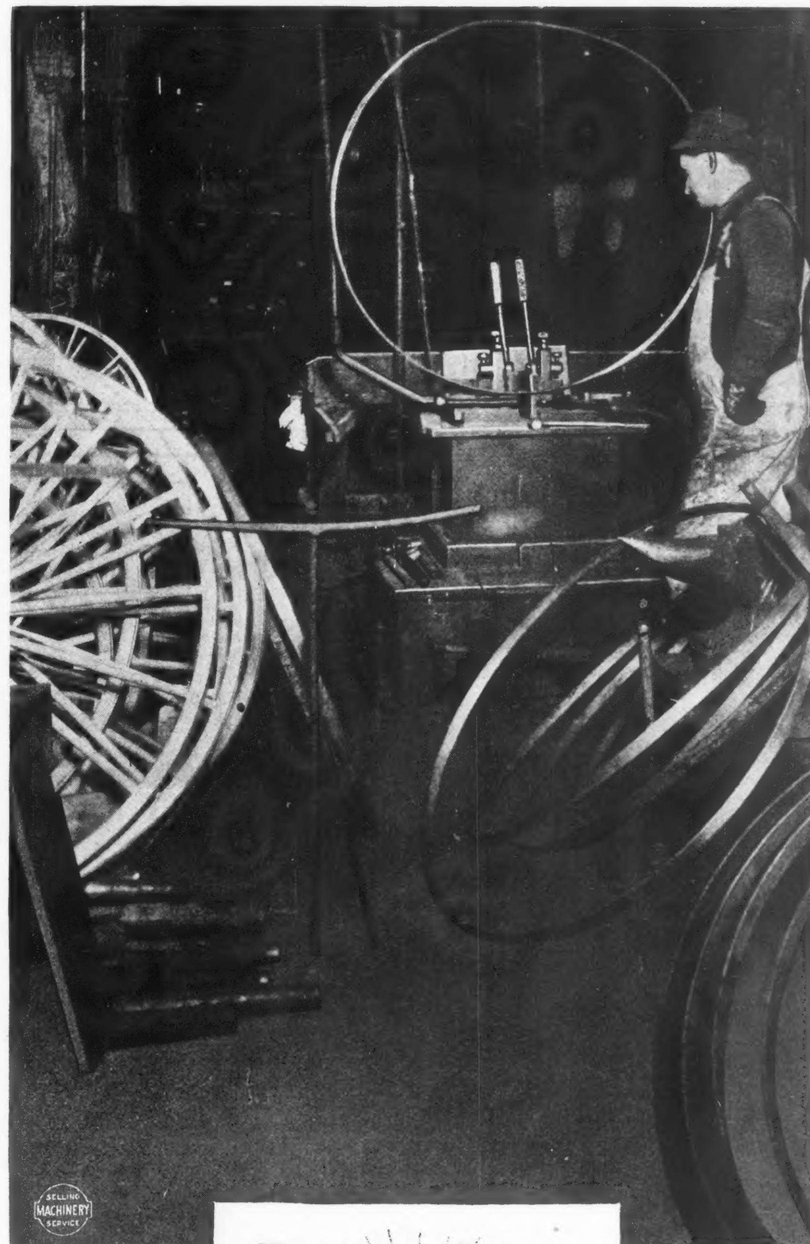
The Automatic Threading Lathe does not compete with dies or thread millers in their range of work. Rather, it outclasses both, handling that fine, exact work—threads of every character, particularly those of large diameter—that can be cut satisfactorily only on a lathe.

It triples output and lowers costs because it does automatically what must be done by the operator on any engine lathe, and one man can attend a battery.

Information?

AUTOMATIC MACHINE COMPANY, Bridgeport, Conn.

AGENTS: Burton, Griffiths & Co., Ltd., of London, England. Marshall & Huschart Machinery Co. of Chicago, Ill. Motch & Merryweather Machinery Co. of Cleveland, O., and Vandyck Churchill Co. of New York.

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BEST MADE BY
Stewart Process
Complicated and intricate parts require superior facilities, skillful designing of dies, and a vastly superior degree of technical and mechanical ingenuity to insure satisfactory die-castings.
The Stewart staff of engineers, diemakers, metallurgists and machine operators have had years of experience in the production of the most complicated parts ever designed.
That is why Stewart Process die-castings are acknowledged to be representative of the highest standard in die-casting engineering.
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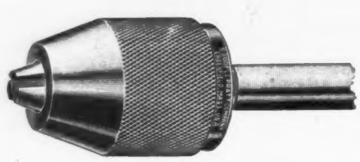
1500 GOOD TOOLS

IMMEDIATE DELIVERY

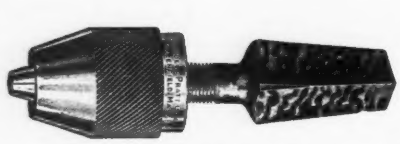
on Goodell-Pratt and Greenfield Drill Chucks



Goodell-Pratt Drill Chuck
½" Inch Round Shank

Goodell-Pratt Drill Chuck
Morse Taper Shank

Goodell-Pratt Drill Chuck
Bit Brace Shank



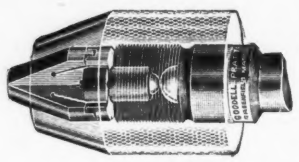
Goodell-Pratt Drill Chuck
Shank Fitting No. 2 Ratchet

At the present time we have in stock, or can assemble within a very short time, all styles and sizes of Goodell-Pratt and Greenfield Drill Chucks.

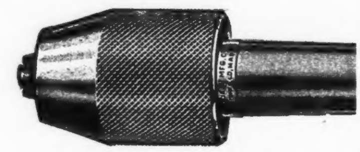
These chucks are made entirely of steel, are very simple in construction, but will be found equal in accuracy and durability to many that are very much more expensive.

We make such extraordinarily large quantities of these chucks for use on our various drilling devices that we are able to sell them at remarkably low prices.

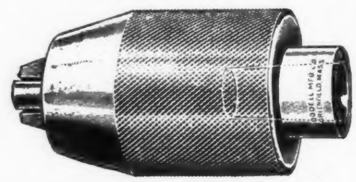
These chucks are regularly made in four different capacities up to ½ inch. They can be furnished with ½ inch, 41/64 inch, bit brace, or Morse taper and other shanks; or without shanks if desired.



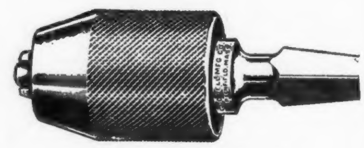
Greenfield Drill Chuck
Sectional View



Greenfield Drill Chuck
Morse Taper Shank



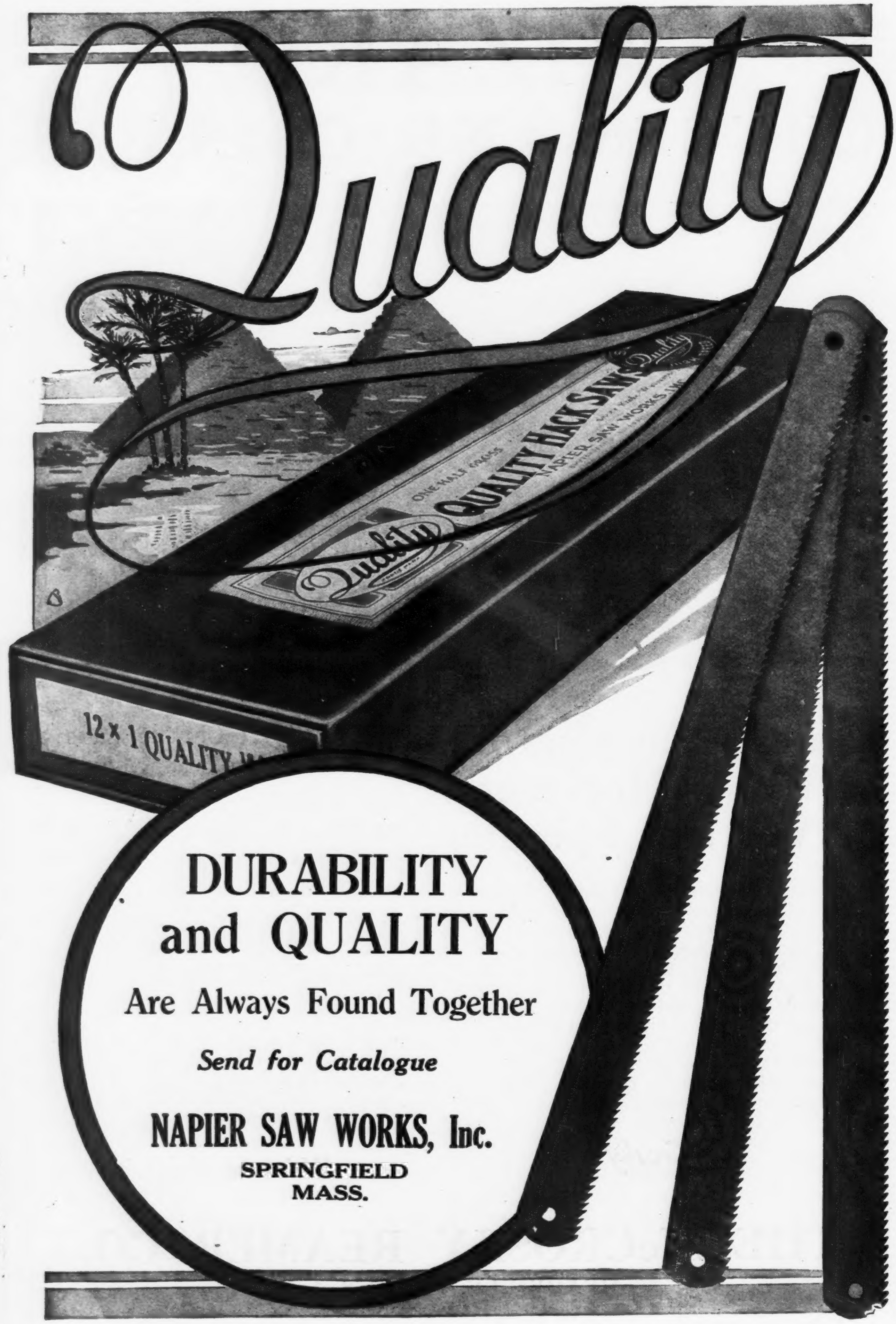
Greenfield Drill Chuck
Taper Hole



Greenfield Drill Chuck
Bit Brace Shank

GOODELL - PRATT COMPANY

GREENFIELD *Toolsmiths* **MASS., U. S. A.**


Quality
ONE-HALF GROSS
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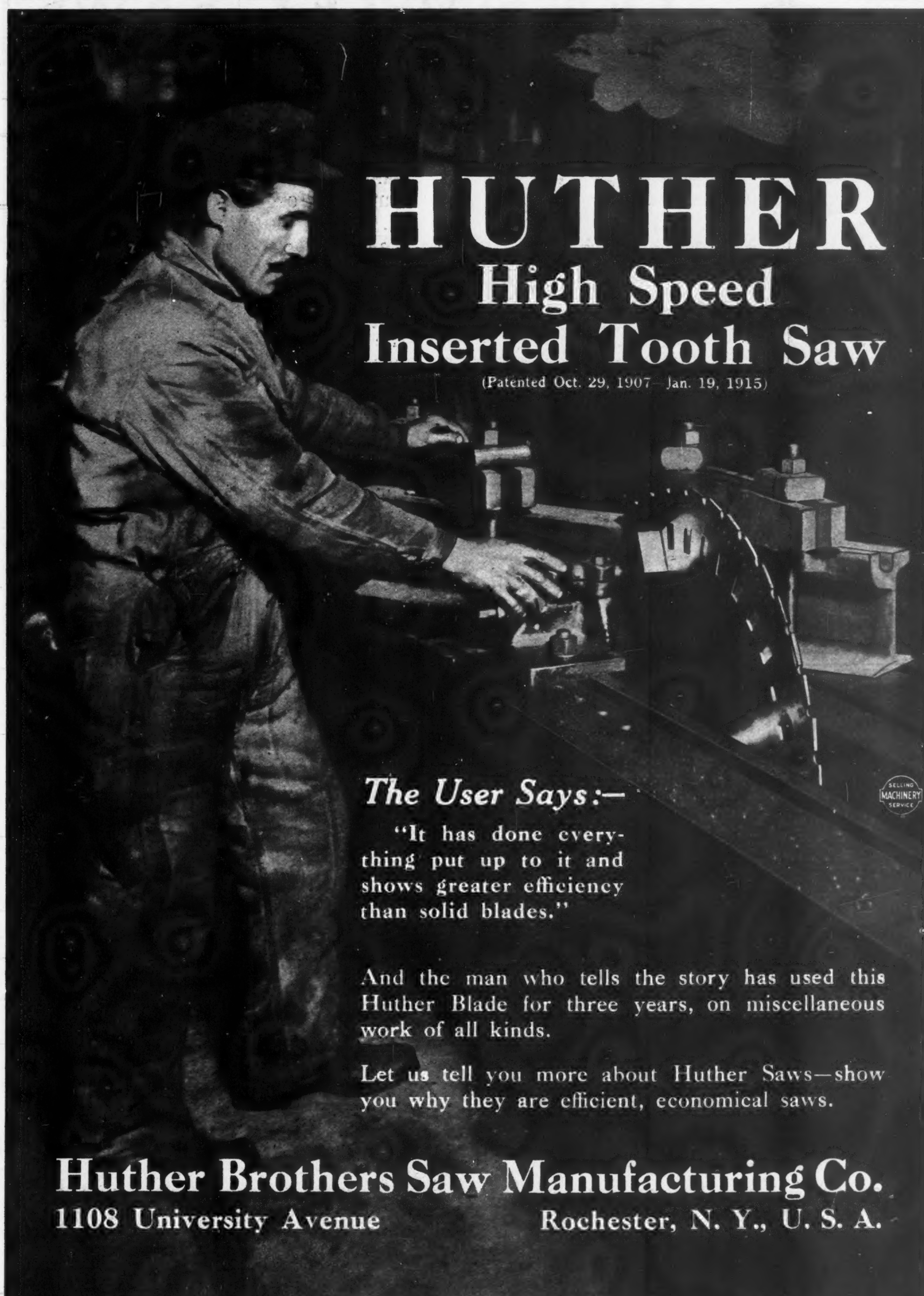
NAPIER SAW WORKS, INC.
Quality
12 x 1 QUALITY
DURABILITY
and QUALITY
Are Always Found Together
Send for Catalogue
NAPIER SAW WORKS, Inc.
SPRINGFIELD
MASS.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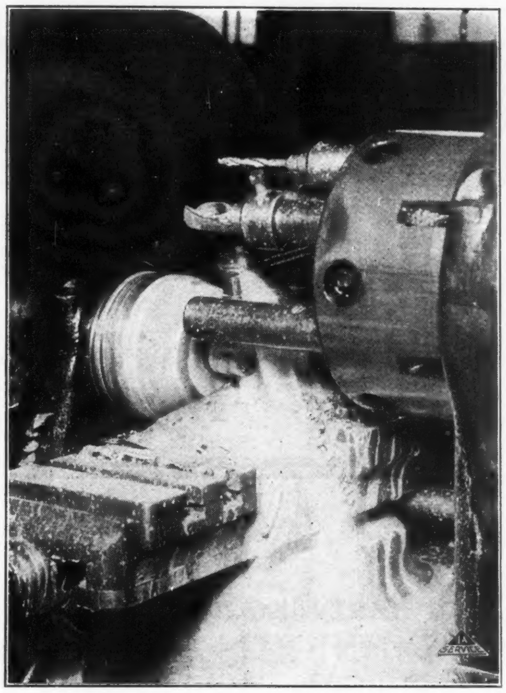
High Speed
Inserted Tooth Saw
(Patented Oct. 29, 1907 Jan. 19, 1915)
The User Says:—
"It has done everything put up to it and shows greater efficiency than solid blades."
And the man who tells the story has used this Huther Blade for three years, on miscellaneous work of all kinds.
Let us tell you more about Huther Saws—show you why they are efficient, economical saws.
Huther Brothers Saw Manufacturing Co.
1108 University Avenue Rochester, N. Y., U. S. A.



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When your work is coming fast, and production is needed badly, you will appreciate the speed increasing qualities of Mystic Cutting Compound. Mystic keeps tools cool and cutting edges in good trim. The leading lubricant for turrets, automatic bolt cutters, drilling and milling machines.

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Weco Ovens have been developed to the highest point of efficiency. They are simple, easily and perfectly controlled, clean, safe, and do their work rapidly and economically. Adapted for steel temper drawing, steel heating, brass and copper annealing, and for dry heat tempering of high speed and carbon steel tools. Temperature ranges from 70 degrees F. to 1100 degrees F. If you want accurate, uniform results you can get them with a Weco Electric Oven.

"Dry Heat Process of Temper Drawing" sent on request.

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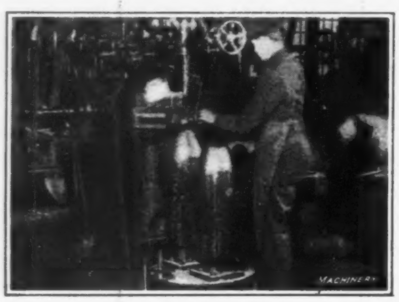
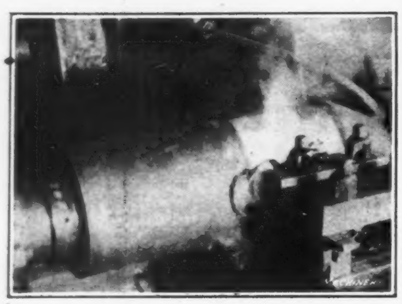
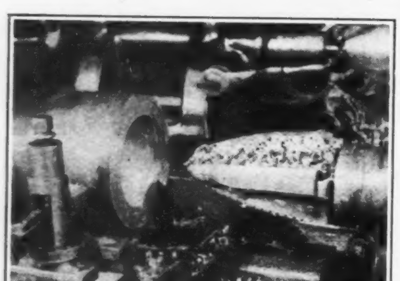






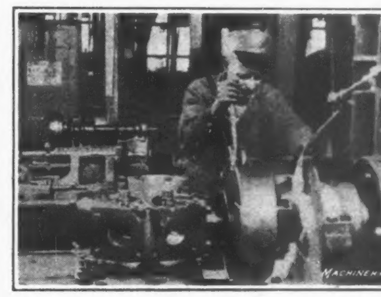
MACHI
MOTION

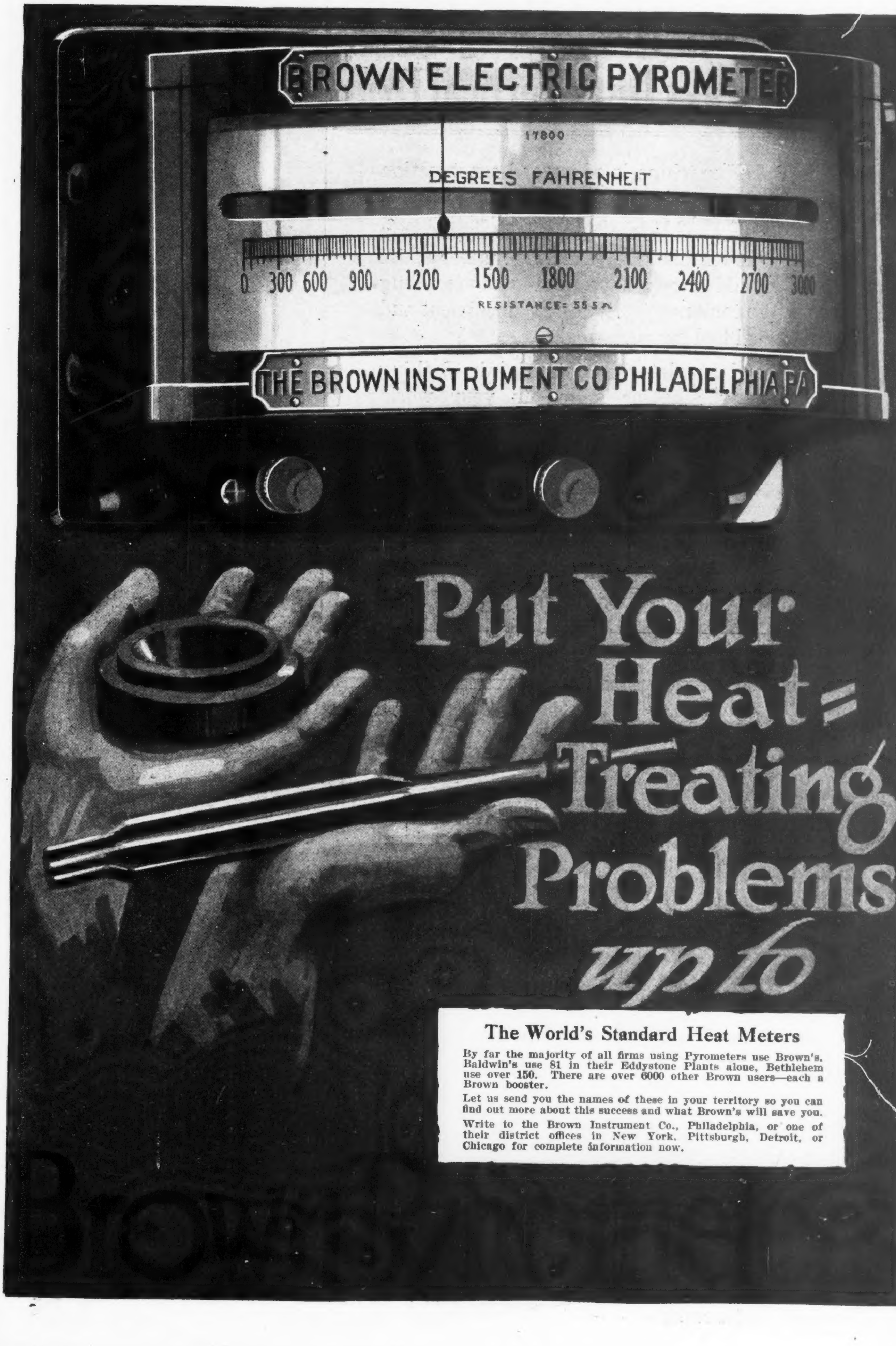
Showing clearly and vividly every High-Explosive

THIS extraordinary motion picture continues MACHINERY'S "bit," which began with the remarkable treatise on Shrapnel Shell Manufacture printed *more than three years ago,* and has furnished the government as well as engineers and manufacturers a mass of definite specific information on mechanical methods and processes in the making of Shrapnel, High-Explosive Shells, Rifles, Gauges, and other devices of the utmost importance to a modern nation engaged in or preparing for war. MACHINERY was the first journal in the world to cover these subjects and did it long before Uncle Sam found it necessary to join the Allies. It was a work of preparedness, was read and studied by the whole engineering world—and it served in good time.

MACHINERY'S motion picture was arranged, made, and produced by MACHINERY'S Staff, and shows in detail every operation from the rough forging of the shell to the final inspection and packing for shipment. As a movie it is different. You see exactly what the cutting tool is doing and you see each test clearly made. Detail drawings flashed upon the screen between the operations show exactly what each step in the process means.

MACHINERY, 140-48




BROWN ELECTRIC PYROMETER
17800
DEGREES FAHRENHEIT
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RESISTANCE= 55.5 Ω
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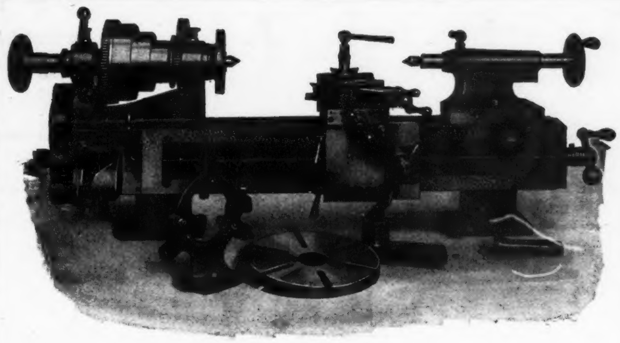
Put Your Heat-Treating Problems up to
The World's Standard Heat Meters
By far the majority of all firms using Pyrometers use Brown's. Baldwin's use 81 in their Eddystone Plants alone, Bethlehem use over 150. There are over 6000 other Brown users—each a Brown booster.
Let us send you the names of these in your territory so you can find out more about this success and what Brown's will save you.
Write to the Brown Instrument Co., Philadelphia, or one of their district offices in New York, Pittsburgh, Detroit, or Chicago for complete information now.



Wade 8" Precision Lathe

This lathe is designed for tool room, experimental and scientific work—for use wherever close accuracy is of prime importance. Nothing but the best in design and construction; only honest values go—for the Wade is built to take a permanent place in the machine tool field.

A strong feature is the quick change gear mechanism which provides for any thread from 12 to 120 per inch. Other features include a set of eleven spring chucks, two face plates, ground tool-steel bearings and draw-in type spindle, covered gears, etc.

Complete description on request

WALTER H. WADE

311 Atlantic Ave. Boston, Mass.

AGENTS: T. Crowther & Co., Boston, Mass. L. R. Meisenhelter Machinery Co., Philadelphia, Pa. E. A. Kinsey Co., Cincinnati, Ohio. International Commercial Co., New York, for Russia. Alfred Herbert, Ltd., Coventry, England. Charles Churchill & Co., Ltd., London, Eng.

BLOMQUIST-ECK

No. 1 DRILL

Simple Low Cost An Excellent Investment

Details on Request

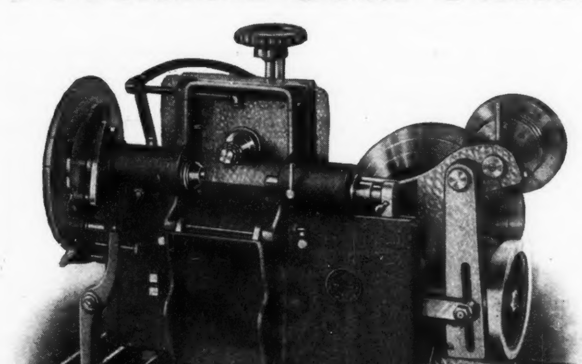
There's a place for this drilling machine in your shop if there is any quantity of bench drilling to perform. This drill answers requirements with the same speed, accuracy and uniformity that has always characterized Blomquist-Eck Machines. It is strong, compact, has two speed changes, drills up to ½".

The Blomquist-Eck Machine Company

203 St. ClairAve., N.E. CLEVELAND, OHIO

AGENTS: Northern Mchy. Co., Minneapolis, Minn. Strong, Carlisle & Hammond Co., Cleveland, Ohio. Essley Mchy. Co., Chicago, Ill.

The Waltham 4" Precision Gear Cutter



A profitable little machine for the shop that makes small gears and fine pitch pinions. The "Waltham" is automatic in operation, has all working parts protected and is a speedy producer of accurate work. When cutter slide is in cutting position and cut in progress, it is tightly clamped; clamp is released on return stroke so slide may be lifted for indexing.

Complete description on request.

Waltham Machine Works

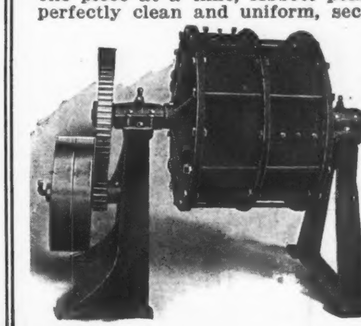
Newton Street WALTHAM, MASS.

Small Thread Millers, Gear Cutters and other small Automatic Machines

MACHINE TOOLS
THE
E·L·ESSLEY MACHINERY
Co
CHICAGO

Burnishing Up-to-Date

The modern idea of burnishing small metal parts—the most in the shortest time—is developed to the last notch by the Abbott Tumbling Barrel process. Hand polishing turns out one piece at a time, Abbott polishing—hundreds. Finish is perfectly clean and uniform, secured without injury to the work. And it's particularly cheap in labor—one operator handling four or five machines.



We'll gladly burnish samples of your work free and estimate on costs.

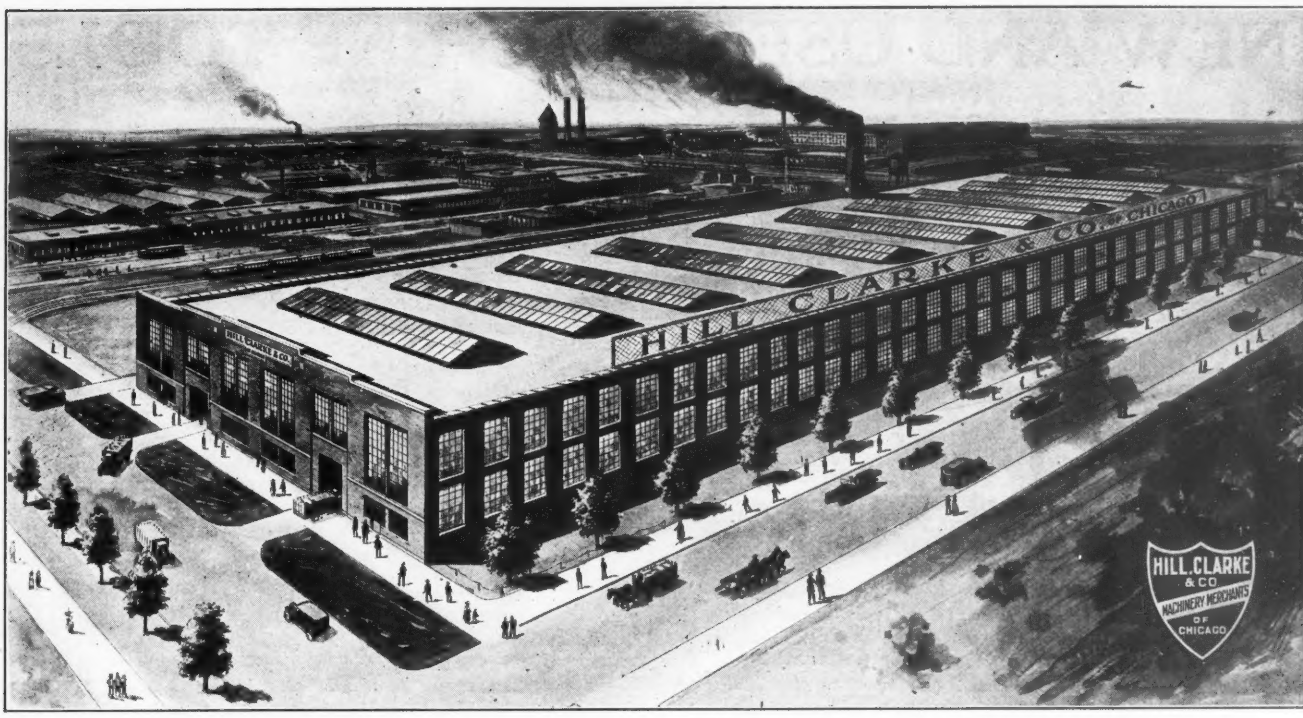
THE ABBOTT BALL COMPANY

(ELMWOOD)

HARTFORD CONN.

Second-Hand Machinery, Tools and Accessories

NEW, REBUILT AND USED MACHINERY



The Only Re-Manufacturing Plant in the World, 55,000 Sq. Ft. of floor space

TURRETS—Latest Models

25—21" Gisholts, 2-step, 5" belt, 3½" hole.
25—21" Gisholts, motor arrangement, 3½" hole.
15—24" Gisholts, 3-step, 4" belt, 4¼" hole.
40—24" Gisholts, 2-step, 6" belt, 6" hole.
42—24" Gisholts, motor arrangement, 6" hole.
4—3-A Warner & Swasey.

ENGINE LATHES—Latest Models

24—22" x 8' Hamilton, D.B.G., C.R., Semi-Q.C.G.
5—22" x 8' Hamilton, D.B.G., turret tool post.
7—22" x 10' Hamilton, D.B.G., C.R., Semi-Q.C.G.
2—22" x 10' Hamilton, D.B.G., turret tool post.
20—22" x 10' Davis, D.B.G., C.R., Q.C.G.
4—22" x 8' Davenport, D.B.G., turret tool post.
8—24" x 10' Lodge & Shipley, D.B.G., C.R., Q.C.G.
8—24" x 10' Lodge & Shipley, Selective Gd. Hd., C.R.
11—26" x 10' American, D.B.G., C.R., Q.C.G.
2—25" x 10' American, D.B.G., carriage turret.
19—26" x 12' Putnam, carriage turret, Semi-Q.C.G.
9—26" x 12' Putnam, C.R., Semi-Q.C.G.
2—26" x 12' Wickes, D.B.G., ,C.R. Semi-Q.C.
10—28" x 10' Niles, Bement, Pond, Q.C.G.
4—28" x 14' Lodge & Shipley, Select. Gd. Hd., C.R., carriage turret.
3—30" x 16' Lodge & Shipley, Select. Gd. Hd., C.R., carriage turret.
11—40" x 18' Pittsburgh Triple Geared, Q.C.G.

VERTICAL BORING MILLS

1—30" Baush.
1—32" Rogers.
2—34" Colburn.
1—36" Brown & Sharpe Chucking.
1—42" Colburn, 2 hds.
1—51" Baush, 2 hds.

RADIALS

3—2½' Fosdick.
2—2½' Mueller.
1—2½' Dreses.
1—3' Prentice.
1—3' Mueller.
1—3½' Gang.
1—4' Niles Full Universal.
3—5' Niles Semi-Universal.

PLANERS

1—22" x 22" x 5' Flather.
1—22" x 22" x 6' American.
1—24" x 24" x 4' Gray.
2—24" x 24" x 5' Gray.
1—24" x 24" x 6' Cincinnati.
1—24" x 24" x 10' Lodge & Davis.
1—26" x 26" x 6' American.
1—30" x 30" x 10' Powell, 4 hds.
1—32" x 32" x 8' Gray, 2 hds.
1—32" x 32" x 10' Gray, 2 hds.
1—76" x 48" x 18' Woodward & Powell, 4 hds.

PRESSES

1—No. 30 Perkins Inclinable.
1—No. 5 Niagara Geared.
1—No. 5 Consolidated.
1—No. 20-U Ryerson Punch.
3—No. 73½ Bliss S. S. Trimming.
1—No. 23½-B Niagara Toggle.
1—Long & Allstater Geared Punch.
1—No. 17 Williams & White Double End Punch.

MILLERS

1—No. 3 Brainard Plain.
1—No. 20 Oesterlein Universal.
1—No. 1½ Brown & Sharpe Universal.
1—No. 25 Becker Plain.
1—No. 2 Cincinnati Universal.
1—No. 5 Schuchardt & Schutte Plain.
1—No. 3 Hendey Plain.
1—60" x 48" x 8' Ingersoll Slab.
1—Beaman & Smith, 2 vert. hds., 1 horiz. hd.
1—No. 2 Beaman & Smith Combination.

GEAR CUTTERS

1—No. 1 S. & S. Hobber, spiral.
1—No. 12 B. & S., spur and bevel.
1—24" Fellows Gear Shaper.
2—No. 3-26" Cincinnati Spur.
1—36" Fellows.
1—36" Gleason Former, spur and bevel.
1—84"—96" Gleason Planer, spur and bevel.

ReMANUFACTURED -(ORIGINATED BY US)- MACHINE TOOLS

Our Guarantee:—Your money back, if you return machine within 30 days from date of shipment, freight prepaid. No excuses necessary.

Our new "Green List" just out, describes the above machines and hundreds of others. Write for one.

HILL, CLARKE & CO. of CHICAGO

625 Washington Blvd. CHICAGO, ILL., U. S. A.

W. F. DAVIS MACHINE TOOL CO.

CHICAGO, ILL., 549 W. Washington Blvd. CLEVELAND, O., 508 Leader News Bldg.
CINCINNATI, OHIO, 1018 Union Central Life Bldg.
NEW YORK CITY, Singer Bldg.

BORING MACHINES—VERTICAL

1—30" Colburn, one turret head.
1—34" Rogers, one turret head, September delivery.
1—34" Gisholt, including motor.
2—36" N.-B.-P., one plain and one swivel head.
2—36" B. & S., one turret head.
12—New 42" Putnam, two heads, November delivery.
1—53" N.-B.-P., two swivel heads.
1—72" Niles, two swivel heads.
1—New 8' Bickford, December delivery.

BORING MACHINES—HORIZONTAL

1—Lucas, 2¼" bar.
1—Hoefer Horizontal Driller and Borer, with 1 11/16" spindle; vertical adjustment, 40"; horizontal adjustment, 46"; size of table, 33" x 48".
2-spindle Beaman & Smith, 3¾" bar. Page 48, G. of G. 1907 Cat.

BULLDOZERS

1—New No. 4 Garrison (same as No. 4 Williams-White).
1—No. 7 Ajax, 20" stroke.
1—No. 7 High Speed Ajax, 16" stroke.

COMPRESSORS—AIR

1—8" x 8" Curtis, belt driven.
1—10" x 10" x 10" Single Cylinder Smith-Valle, steam driven.
1—10" x 12" Chicago Pneumatic, belt driven.
1—10 x 16½" x 13" Peerless, cross compound, steam driven.
1—22"-13" x 16" Ingersoll-Rand, motor driven.
1—Ingersoll-Sargent Duplex, 8 x 14½ x 8".
1—Ingersoll-Sargent, steam driven, 345 cu. ft.
1—Cincinnati, cross compound, two stage, 790 cu. ft.

CUTTING-OFF MACHINES

2—No. 00 Brown & Sharpe.
1—2" capacity Warner & Swasey.
4—3½" Hall.
10—4½" Williams.
3—4" Curtis & Curtis.

DRILLING MACHINES—RADIAL

2—New No. 3 American, plain, cone drive.
3—New 3' Americans, sensitive tapping attachment.
7—New 3' Prentice, July delivery.
1—New 3' Mueller, plain, speed box drive.
1—New 3½' Mueller, cone drive, July delivery.
1—New 3½ Western Drill, 86" circle.
2—4' Mueller, plain, speed box drive.
1—3' Bickford, gear drive.
1—5' Bickford, plain, speed box drive.
1—5' American, plain, motor drive.
5—5' Spindle, arm does not raise and lower, hand feed.
1—5' Fosdick, plain, cone drive, tapping attachment.
1—6' Baush, plain, cone driver.

DRILLING MACHINES—HEAVY DUTY

3—No. 14 Colburn, 24" swing, capacity 2" in solid steel.
2—No. 3 Colburn, plain, table.
2—No. 26 Foote-Burt, 44" swing, 3½" capacity in solid steel.
1—No. 310 Baker, single pulley drive, late type.

DRILLING MACHINES—MULTIPLE SPINDLE

1—No. 30 C. Baush, 12 spindle, capacity 1⅛" holes, 30" circle.
1—No. 24 Baush, 12 spindles.
1—Gardam, 12 spindle, capacity ⅜" holes, 14" square.
1—14-spindle Baush, capacity 1" holes, 36" circle.
1—No. 11 Pratt-Whitney, 16-spindle, cap. 10 spindles, ¼" cap.

GEAR CUTTING MACHINES

1—New 6" Standard Gear Cutter, Spur.
1—12" G. & E. Gear Hobber.
1—12" Gleason Bevel Gear Planer.
1—15" Gleason Bevel Gear Planer
1—16" Bilgram Bevel Gear Generator.
1—20" Grant-Lee Gear Hobber.
1—No. 1 20" Schuchardt & Schutte Gear Hobber.
1—22 x 8 G. & E. Spur and Bevel Cutter.
1—24" Fellows Gear Shaper.
1—24" x 8" G. & E., for spur and bevel.
1—26" x 10" Cincinnati, spur gears only.
1—New 30" Flather, spur gears only.
3—36" Fellows Gear Shapers.
1—No. 3 Brown & Sharpe Auto. Gear Cutter, Spur.

GRINDERS—UNIVERSAL, FOR CUTTERS, DRILLS, REAMERS, ETC.

1—New Norton No. 1.
1—New Wilmarth & Morman, style B X.
1—No. 1 Cincinnati.
1—New Walker No. 2, outfit K (capacity 9" x 26").
8—No. 180 Wells.

GRINDING MACHINES—CYLINDRICAL—PLAIN

1—No. 11 (6" x 30") Brown & Sharpe.
1—6" x 48" Pratt & Whitney.
1—New No. 12 (8" x 26") Brown & Sharpe.
1—10" x 50" Norton.
1—New 10 x 72 Norton, plain.
1—No. 16 (10" x 72") Brown & Sharpe.
20—12" x 24" Modern, self-contained.
6—12" x 36" Modern, self-contained, motor or belt driven.
6—12" x 48" Modern, self-contained, motor or belt driven.
1—16" x 66" Landis, with crank grinding.
1—12 x 32 Landis, rebuilt.
1—18" x 96" Brown & Sharpe.
1—New 10" x 36" Landis. Immediate.

GRINDING MACHINES—CYLINDRICAL—UNIVERSAL

1—No. 1 Fraser, with surface grinding attachment.
1—No. 1½ (10" x 30") Landis.
1—No. 2½ (10" x 36") Bath.
1—No. 2 (9" x 20") Bath.
1—New No. 2 Bath.
1—No. 2 New Walker, 9" x 26".
1—10" x 42" Modern.
1—No. 2 (12" x 30") Brown & Sharpe.
1—New No. 2 Morse Cap. 12" x 30", universal, December delivery.
1—No. 3 (12" x 40") Brown & Sharpe.
1—12" x 42" Landis.

GRINDING MACHINES—INTERNAL

1—No. 1½ Landis.
1—No. 70 Heald.
1—No. 75 Heald.

GRINDERS—CYLINDER

1—No. 27 Brown & Sharpe.
1—No. 60 Heald, single pulley drive.

GRINDERS—DISC

1—No. 14 Besly.
1—New No. 17 Gardner (Pattern Makers).

GRINDING MACHINES—RING

1—No. 200 Heald.
1—No. 210 Heald.

GRINDING MACHINES—EDGE

1—No. 374 Safety Emery Wheel Co.

GRINDING MACHINES—SURFACE

1—No. 1 Diamond, capacity 12" x 12" x 24", automatic.
4—New No. 2 Reid (same as B. & S.).
1—22" x 12" x 60" Springfield, planer type, automatic.
1—New No. 1 Wilmarth & Morman.

GRINDING MACHINES—DUPLEX

1—No. 5 Bath, suitable for grinding cylinders, pistons, piston rings, etc., 16" feed, swivel table, water pump.

GRINDING MACHINES—FACE

1—Diamond Face Grinder, 4' travel, 14" wheels.

HAMMERS—POWER, FORGING

1—40-lb. Bradley Helve.
1—150-lb. Bradley Helve, upright.

HAMMERS—BOARD LIFT, DROP

1—400-lb. Billings & Spencer.
1—2000-lb. Chambersburg.

HAMMERS—STEAM, FORGING

1—New 600-lb. Bell.
1—New 3000-lb. Bell, September delivery.

KEYSEATERS

2—No. 0 Mitts & Merrill.
1—No. 2 Mitts & Merrill, motor driven.
1—60" stroke Compton-Knowles Broacher.
6—New 12 x 4 Shepard, reverse head.
8—New 12 x 5 Shepard, reverse head.
3—New 12 x 6 Shepard, reverse head.

LATHES—MANUFACTURING—NOT SCREW CUTTING

13—No. 3 X Reed-Prentice, semi-automatic.
14—Reed-Prentice Shell Lathes for 4" or 18-lb. American shells.
60—14" x 6' Reed Stud and Bolt.
5—16' x 8' Fairbanks-Morse, heavy duty.
70—New Simplex, 16" x 8'.
14—16 x 8 Simplex, single pulley drive.
22—18" x 8' Battle Creek, heavy duty.
5—20" x 8' Merschon.
50—20" x 10' Hindman, high duty.
12—21" x 8' LeBlond, quick change, with attachment for grooving and facing both ends of shells, with air cylinders and mandrels for 5" shells.

LATHES—ENGINE

6—New 12 x 4 Shepard reverse head.
8—New 12 x 5 Shepard reverse head.
3—New 12 x 6 Shepard reverse head.
1—14" x 6' Bradford, taper attachment.
2—16" x 6' LeBlond, pan bed, quick change gears, taper attachment.
1—18" x 8' L. & S., geared head, taper.
1—18 x 10 Hendey, quick change gear, 14" chuck.
3—18" x 9' Chard.
1—New 19" x 8' LeBlond, heavy duty.
22—20" x 8' Lodge & Shipley, quick change gear.
7—New 20" x 8' American, heavy duty.
9—22" x 10' Putnam, oil pan, turrets.
4—24" x 10' Reed.
2—24" x 12' S. & B.
1—24" x 14' Lodge & Shipley, patent head.
4—24" x 14' American, quick change.
3—New 26" x 12' Boye & Emmes.
1—26" x 24' New Haven.
4—New 28" x 12' Boye & Emmes.
1—28" x 18' S. & B.
5—New 30" x 14' Boye & Emmes.
3—New 32" x 12' Pittsburgh pattern.
1—36" x 15' Fifield, 36 x 16".
8—New 36" x 24' Putnam, triple geared.
1—38 x 19' Steptoe, single back gear.
1—24"-45" x 22' McCabe, double spindle.
1—48 x 27' x 9" Betts, triple back gear.
1—60 x 27 Betts, triple back gear.
1—New 66" x 30' Putnam, December delivery.
1—71" x 20' Fifield, triple geared.

LATHES—TURRET

5—2 x 24 Jones & Lamson.
5—3 x 36 Jones & Lamson.
18—6A Potter & Johnson.
2—21 Gisholt.

MILLING MACHINES—KNEE TYPE—UNIVERSAL

1—New No. 1 Kempsmith.
1—No. 1½ Hendey-Norton.
1—No. 2 Kempsmith, back geared.
1—No. 2 New Cincinnati.
2—No. 2½ LeBlond, September delivery.
2—No. 3-H LeBlond, September delivery.
1—No. 3 Cincinnati, single pulley drive, high power, vertical attachment.
1—New No. 4 LeBlond Heavy Duty. Immediate.

MILLING MACHINES—KNEE TYPE—PLAIN

1—No. 0 Pratt & Whitney.
3—New No. 1 Rockford.
2—New No. 1 Kempsmith.
1—½ American.
1—New No. 2 Rockford.
1—No. 3 LeBlond.
1—No. 3 Cincinnati.
1—No. 4 Garvin.

MILLING MACHINES—VERTICAL

4—New No. 4 B Becker.
1—No. 2 New Cincinnati.
2—No. 5 Becker.

MILLING MACHINES—PLANER TYPE

1—No. 2 Beaman-Smith.
2—Ingersoll Slab Millers, working surface of table 60" x 20".
1—No. 4 Beaman & Smith, vertical spindle, open side, working surface of table 120" x 24", removable housing on one side.

PLANERS

1—24" x 24" x 6' Gray, one head on cross rail.
1—26" x 26" x 8' Gray, one head on cross rail.
1—30" x 30" x 8' Gale Planer, one head.
1—30" x 30" x 8' Whitcomb, one head.
1—New 36" x 36" x 12' Powell, high speed, one head.
1—36" x 30" x 12' New Haven, one head.
1—36" x 36" x 9' Sellers, four heads.
1—36" x 36" x 9' Sellers, two heads.
2—New 36" x 36" x 12' Woodward & Powell, two heads on cross rail, one side head, October delivery.
1—36" x 36" x 14' Sellers, four heads.
1—42" x 10' Hewes & Phillips, one head on rail, one side head.
1—42" x 10' Hews & Phillips, one head on
1—48 x 48" x 16' Sellers, one rail head, two side heads.
1—50" x 14' Powell, one head.
1—72" x 72" x 26' motor drive, Betts, four heads.

SCREW MACHINES AUTO.

3—No. 51 National Acme.
2—No. 52 National Acme.
2—No. 53 National Acme.

SHAPERS

1—New 16" Springfield.
1—16" Motor Driven, Rockford.
2—New 24" Milwaukee.
1—New Barker 24".
3—New 24" Steptoe. Back Gear.

RIVERSIDE MACHINERY LIST

WE OWN EVERY TOOL OFFERED

ENGINE LATHES

1—28 x 10 Hamilton Standard Engine Lathe, with turret.
1—28 x 15 Putnam Standard Engine Lathe.
1—22 x 14 Putnam Standard Engine Lathe.
3—New 18 x 8 Springfield Engine Lathes.
1—New 16 x 8 Springfield Engine Lathe.
1—New 14 x 6 Springfield Engine Lathe.
1—18 x 6 Jones & Lamson Standard Engine Lathe.
1—16 x 8 Porter Standard Engine Lathe.
2—16 x 8 Reed Stud Lathes.
1—14 x 8 Sebastian Standard Engine Lathe.
1—14 x 6 Lodge & Shipley Engine Lathe.
1—14 x 6 Springfield Engine Lathe.
1—14 x 6 Prentiss Engine Lathe.
1—14 x 6 Sebastian Engine Lathe.
2—14 x 6 Van Werk Engine Lathes.
1—11 x 5 Seneca Falls Engine Lathe.
1—No. 3 Hardinge Bench Lathe.

TURRET AND SCREW MACHINES

1—2¼ x 24 Jones & Lamson Flat Turret Lathe, S.G.H.
1—2 x 24 Jones & Lamson Flat Turret Lathe, cone head.
2—No. 6-A Potter & Johnson Automatic Lathes.
3—No. 4 Foster F.G. H. Hand Screw Machines.
2—No. 3 Foster F.G.H. Hand Screw Machines.
1—No. 5 Pierson F.G.H. Hand Screw Machine.
1—No. 4 Smurr & Kamen Hand Screw Machine.
4—New 14" Pierce Turret Lathes.
2—New 1 x 8 Pierce Hand Screw Machines.
2—2" Cleveland Automatic Screw Machines, jogger feed.

MILLING MACHINES AND GRINDERS

2—No. 3 Cincinnati Universal Cone Type.
5—No. 1½ Knight Milling and Drilling Machines.
2—No. 13 Pratt & Whitney Lincoln Type Milling Machines.
1—No. 1 Cincinnati Plain Milling Machine.
1—No. 13½ Garvin Plain Milling Machine.
1—No. 2 Hendey Plain Milling Machine.
3—Fox Hand Milling Machines.
1—Garvin Hand Miller.
1—No. 2½ Bath Universal Grinder.
1—No. 170 Wells Cutter Grinder.
1—Mina Valley Universal Cutter Grinder.
4—No. 0 Burke Bench Mills. (New.)

DRILL PRESSES

1—3-spindle 8" Overhang Henry & Wright High Speed Drill.
3—12" Leland & Gifford High Speed Bench Drills.
5—20" Buffalo Plain Drill Presses.
4—6 spindle Fox High Speed Drill Presses.
2—4 spindle Fox High Speed Drill Presses.
1—3' Mueller Plain Radial Drill.
1—4' Bickford Radial Drill with T.A.
1—6' Mueller Plain Radial Drill.
1—16 spindle Natco Drill.

SHAPERS AND PLANERS

1—24" Ohio H.D. B.G. Crank Shaper.
1—24" New Barker Crank Shaper.
1—24" Lodge & Davis Geared Shaper.
1—18" Hendey Geared Shaper.
1—16" Hendey Geared Shaper.
1—16" Garvin Shaper.
2—16" New Springfield B.G. Crank Shapers.

PRESSES

1—Waterbury-Farrell Straight Sided Geared Press with double cam knock-out.
1—No. 10 Perkins Drawing Press.
5—No. 2-W Bliss Wiring Presses.
1—800-lb. B. & S. Roll Board Hammer.
1—800-lb. P. & W. Roll Board Hammer.
1—50-lb. Scranton Belt Hammer.
1—25-lb. Bradley Helve Hammer.

AIR COMPRESSORS

1—8 x 6 Westinghouse Steam Air Compressor.
1—16 x 18 x 12 Union Steam Pump Co., Steam Driven Air Compressor.
1—10 x 10 Ingersoll Sargent Belt Driven Air Compressor.
1—10 x 10 Clayton Belt Driven Air Compressor.
1—8 x 8 Fairbanks Morse Electrical Driven Air Compressor.
1—8 x 8 Gardner Single Belt Driven Air Compressor.
1—8 x 8 Union Steam Pump Co. Belt Driven Air Compressor.
1—7½ x 6 Chicago Pneumatic Tool Co. Belt Driven Air Compressor.
1—6 x 6 Chicago Pneumatic Tool Co. Belt Driven Air Compressor.

We also carry a large stock of Steam Engines, Steam Pumps and Electrical Equipment of all kinds.
We are in the market to purchase machine tools, both large and small.

RIVERSIDE MACHINERY DEPOT, 17-29 St. Aubin Ave., Detroit, Mich.

SECOND-HAND MACHINERY FOR SALE BY
THE MOTCH & MERRYWEATHER MACHINERY COMPANY

711 Lakeside Ave., N.W. Cleveland, Ohio

Branch Offices: Detroit, Cincinnati, Pittsburgh.

AUTOMATICS

2" Cleveland.
No. 22 New Britain Chucking.
No. 23 New Britain Chucking.
No. 33 New Britain Chucking.

BROACHING MACHINES

No. 1 J. N. Lapointe.
No. 2 Lapointe Machine Tool Co.
No. 3 Lapointe Machine Tool Co.

DRILLING MACHINES

15" Barnes.
10' Burke Sensitive.
Four-spindle 26" Hoefer Gang.
Four-spindle No. 1½ Foote-Burt Rail.
Four-spinde No. 2 Avey.
Two-spindle No. 2 Avey.

GRINDERS

6" x 32" Norton.
10" x 50" Norton.
10" x 30" Landis.
No. 1 Cincinnati Cutter.
No. 2 Brown & Sharpe, universal.
No. 2½ Bath, universal.
No. 3 Oesterlein.
No. 12 Gardner, duplex disc.
24" Double Wet Tool.
20 x 1½ Single Wet Tool.
No. 200 Heald, ring.

HAMMERS

35-lb. Williams & White, power tire welding.
No. 3 Standard 300-lb. belt drop.
1200-lb. Bell steam.

KEYSEATERS

No. 1 Davis.
No. 2 Mitts & Merrill.
18" x 1½" Norton.

LATHES

14" x 6' Sebastian.
14" x 6' Reed Extra Heavy Stud.
16" x 6' Lodge & Shipley Patent Hd.
16" x 8' Walcott.
16" x 8' Reed Stud.
16" x 6' Harrington.
16" x 10' Rahn-Carpenter.
18" x 8' Lodge & Shipley.
Three step cone, D.B.G.
18" x 8' Lodge & Shipley, Pt. Hd.
18" x 8' LeBlond.
18" x 8' Bradford.
18" x 8' Walcott Q. C.
18" x 10' Monarch Q. C.
18" x 12' Monarch Q. C.
20" x 8' Walcott Q. C.
30" x 14' Lodge & Shipley.

MILLING MACHINES

No. 2 Oesterlein.
No. 7-H Becker, Lincoln Type.
No. 00 Brown & Sharpe.
No. 8 Pratt & Whitney, hand.
No. 10 Pratt & Whitney, hand.

PLANERS

24" x 24" x 5' Blaisdell, one head.
26" x 26" x 6' Pond.
36" x 36" x 10' Sellers, 4 heads.

PIPE MACHINES

12" Curtis & Curtis.

PRESSES

No. 2 Consolidated plain inclinable.
No. 5 Stiles & Parke Blanking Press.

SAWS

6" Atkins "Kwick-Kut."
7" High Duty Paragon.

SCREW MACHINES

1½" Foster, motor drive.
1½" Warner & Swasey.
4½" Bardons & Oliver.

SLOTTERS

12" Industrial.

TURRET LATHES

2" Jones & Lamson.
14" Warner & Swasey.
16" Bardons & Oliver.
21" Gisholt.
22" Libbey.
24" Gisholt.

MISCELLANEOUS

Flywheel balancing machine, Rockford.
Oil Separator, Curtis.

USED MACHINERY FOR SALE

SCREW MACHINES

4—No. 55 National Acme Automatics, 1⅝" capacity, 4-spindle, new within 6 months.
2—Universal Automatics, ¾" capacity, 5-spindle.
1—2" Cleveland Automatic.
1—1¾" Spencer Double End Automatic.
1—1" Pratt & Whitney Automatic.
1—Meridan Tool 2¼" Hand Screw Machine, wire feed and auto. chuck, back geared.

TURRET LATHES

1—Pratt & Whitney No. 3, 2" capacity with drawn collets, back geared, oil pump and pan, power feed turret.

MISCELLANEOUS TOOLS

1—Brainerd Plain Miller, No. 4½.
2—Geometric Threading Machines, fitted with self-opening heads, ¾" dies, new within 6 months.

THE PUFFER MFG. CO., Winchester, Mass.

34 to 42 INCH BORING MILLS

FOR PROMPT DELIVERY

to be used on War Department production. Urgently needed. Reply to

THE WEST STEEL CASTING CO., Cleveland, Ohio

FOR SALE

ENGINE LATHES

FOR IMMEDIATE DELIVERY

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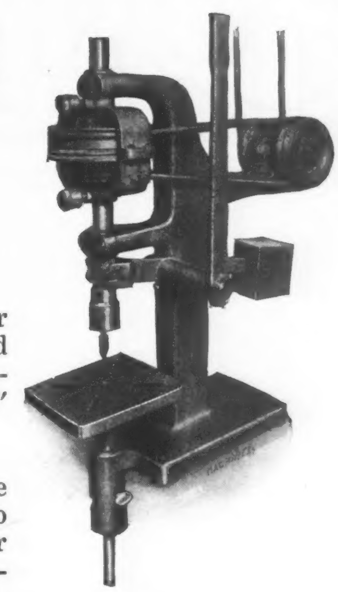

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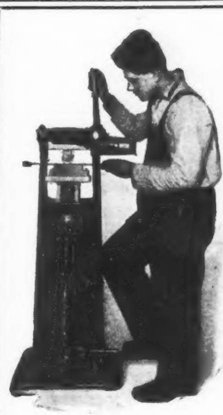

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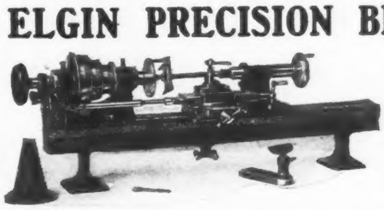

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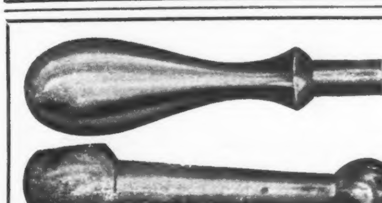

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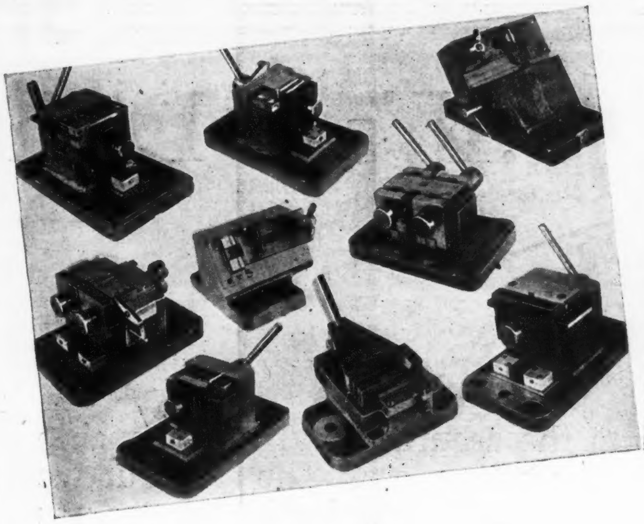

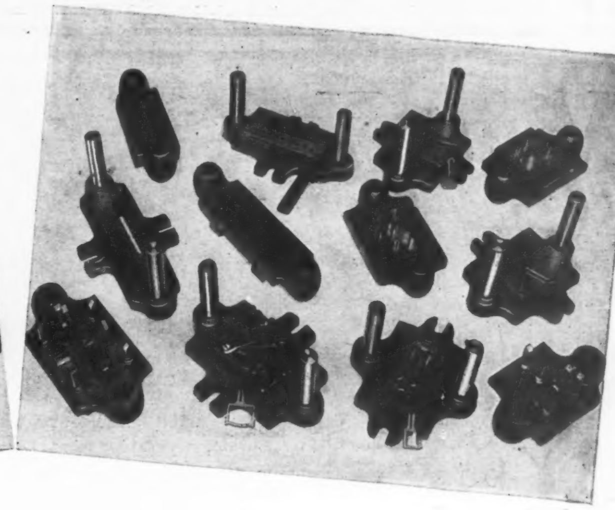

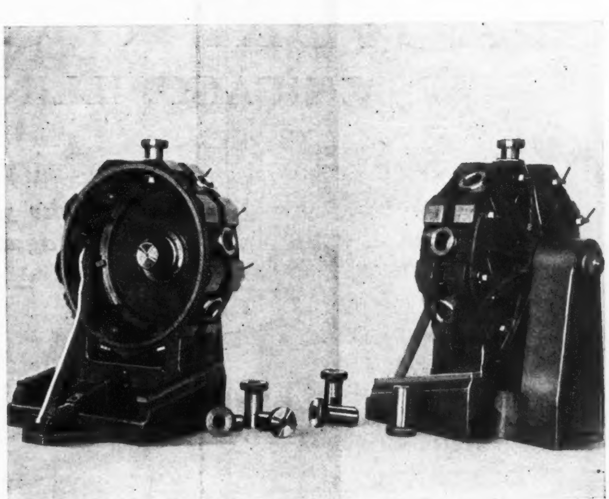


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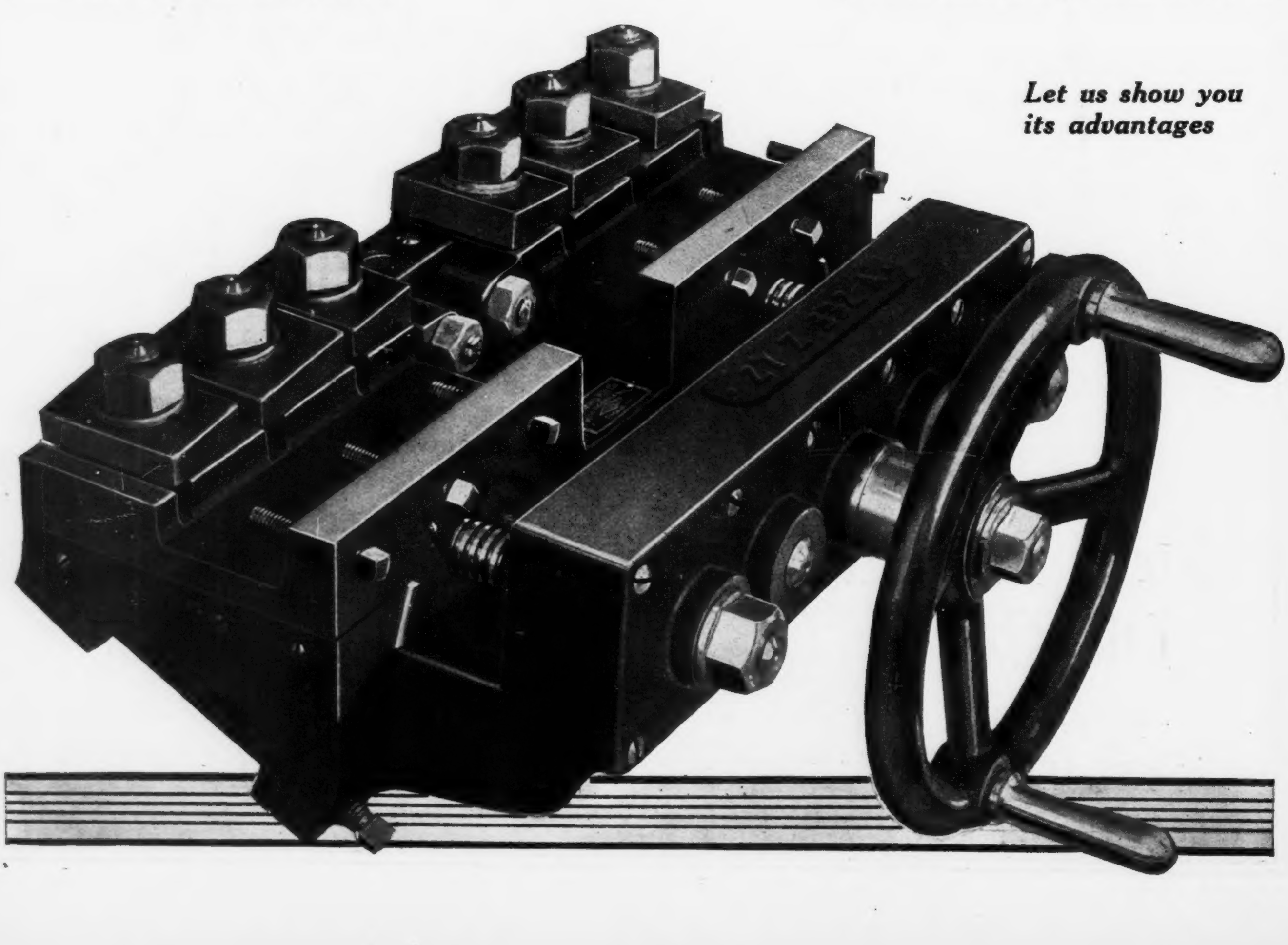

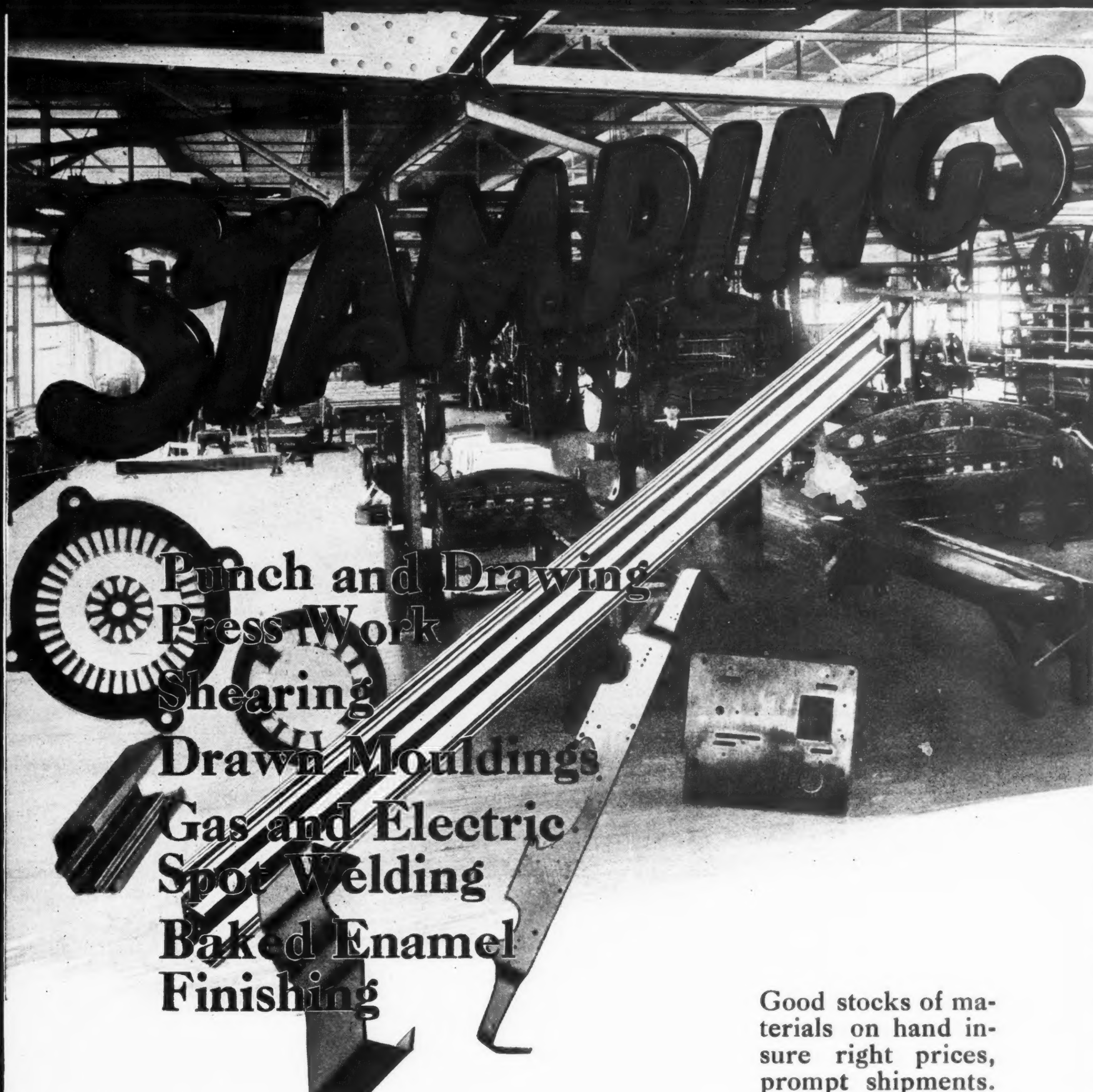

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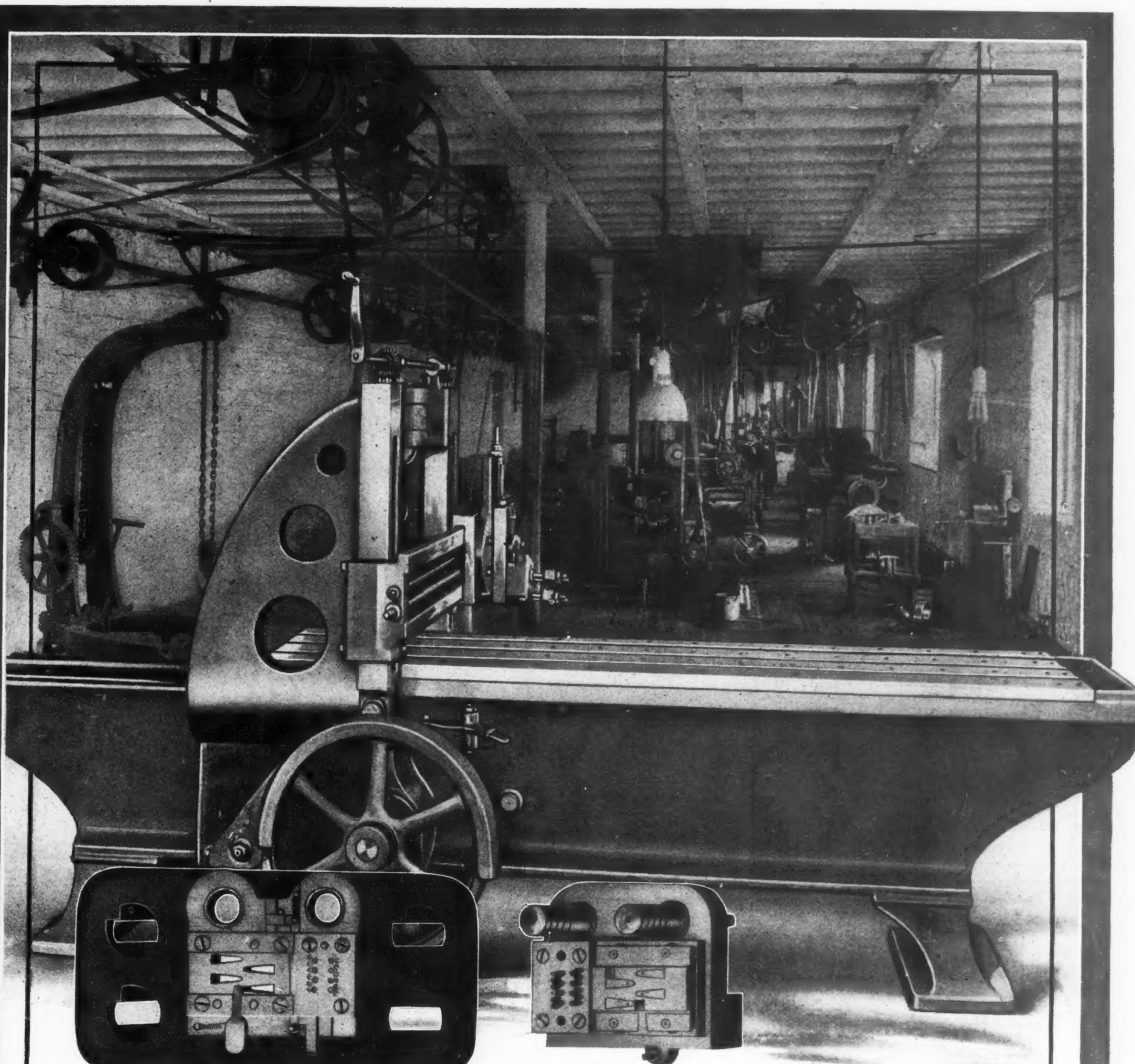

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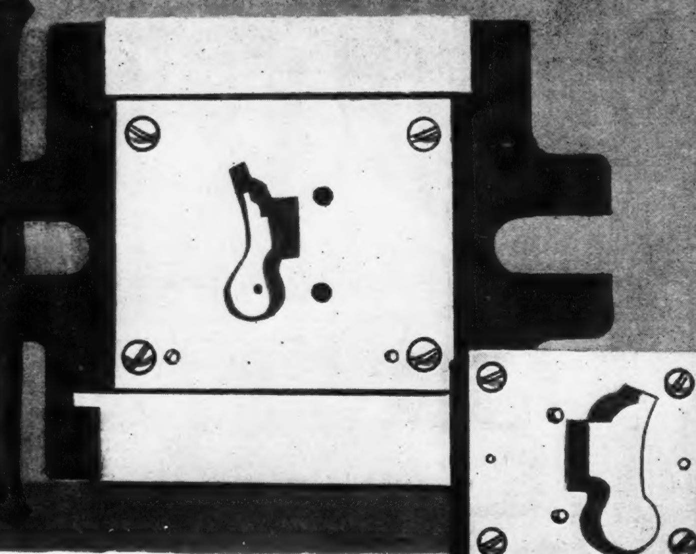

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Brown & Sharpe Mfg. Co., Providence, R. I.
Goodell-Pratt Co., Greenfield, Mass.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
Hannifin Mfg. Co., Chicago, Ill.
Starrett Co., L. S., Athol, Mass.
Western Tool & Mfg. Co., Springfield, O.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Clamps, Pipe
National Tube Co., Pittsburgh, Pa.

Clocks, Watchmen's
Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill.

Clutches, Friction, Etc.
Bicknell-Thomas Co., Greenfield, Mass.
Brown Clutch Co., Sandusky, O.
Brown Engineering Co., 133 No. 3d St., Reading, Pa.
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Conway & Co., Cincinnati, O.
Cresson-Morris Co., Philadelphia, Pa.
Edgemont Mch. Co., 2700 National Ave., Dayton, O.
Johnson Mch. Co., Carlyle, Manchester, Conn.
Link-Belt Company, Chicago, Ill.
Moore & White Co., 2707-2737 N. 15th St., Philadelphia, Pa.
Reliance Gauge Column Co., 6008 Carnegie Ave., Cleveland, O.
Wood Sons Co., T. B., Chambersburg, Pa.

Collars, Safety
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Brown Co., A. & F., 79 Barclay St., New York.
Link-Belt Company, Chicago, Ill.
Safety Emery Wheel Co., Springfield, O.
Standard Pressed Steel Co., Philadelphia, Pa.

Collars, Spacing, Etc.
Detroit Stamping Co., Detroit, Mich.
Scully-Jones & Co., 647 Railway Exchange, Chicago, Ill.

Collets, Spring
See Chucks, etc.
Ames Co., B. C., Waltham, Mass.
Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.

Commutators
Wagner Elec. Mfg. Co., St. Louis, Mo.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Compound, Cleaning
Oakley Chemical Co., 26 Thames St., New York.

Compound, Cutting, Grinding, Etc.
Cataract Refining & Mfg. Co., Buffalo, N. Y.
Fiske Bros. Refining Co., 24 State St., New York.
Haws, Inc., Geo. A., 135 Front St., New York.
Oakley Chemical Co., 26 Thames St., New York.
Stuart & Co., Inc., D. A., 29 So. La Salle St., Chicago, Ill.

Compressors, Air and Gas
Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill.
Curtis Pneumatic Mchy. Co., 1568 Kienlen Ave., St. Louis, Mo.
General Electric Co., Schenectady, N. Y.
Ingersoll-Rand Co., 11 Broadway, New York.
Worthington Pump & Mchy. Corp., 115 Broadway, New York.

Conduits
General Electric Co., Schenectady, N. Y.

Contract Work
American Mch. & Foundry Co., 5520 Second Ave., Brooklyn, N. Y.
American Tool & Mfg. Co., Urbana, O.
Automat Tool Works, 252 Greenwich St., New York.
Carroll Engineering Co., Dayton, O.
Columbus Die, Tool & Mch. Co., Columbus, O.
Fox Gun Co., A. H., Philadelphia, Pa.
Gisholt Mch. Co., Madison, Wis.
Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill.
Harris Engineering Co., H. E., Bridgeport, Conn.
Himoff Mch. Co., 45 Mills St., Astoria, N. Y.
Ingle Mch. Co., Rochester, N. Y.
Krasberg Mfg. Co., 412 Orleans St., Chicago, Ill.
Langelier Mfg. Co., Providence, R. I.
Marvin Mfg. Co., W. B., Urbana, O.
Maute & Sons, J., Buffalo, N. Y.
Mehl Mch. Tool & Die Co., Roselle, N. J.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Moore-Eastwood Mfg. Co., Dayton, O.
Nelson Tool Co., Inc., 781-783 E. 142d St., New York.
New Britain Mch. Co., New Britain, Conn.
North Side Tool Works, Dayton, O.
Ohmer Fare Register Co., Dayton, O.
Poole Engineering & Mch. Co., Baltimore, Md.
Rockford Metal Specialty Co., Rockford, Ill.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Slocum, Avram & Slocum Laboratories, Inc., 531 W. 21st St., New York.
Smalley-General Co., Bay City, Mich.
Solar Metal Products Co., Inc., Columbus, O.
S-P Mfg. Co., Cleveland, O.
Steel Products Engineering Co., Springfield, O.
Steiner Bros., Lima, O.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Taylor Mch. Co., Cleveland, O.
Taylor-Shantz Co., Rochester, N. Y.
T. C. M. Mfg. Co., Harrison, N. J.
Ulmer Co., J. C., Cleveland, O.
Urbana Tool & Die Co., Urbana, O.

Controllers
Eck Dynamo & Motor Co., Belleville, N. J.
General Electric Co., Schenectady, N. Y.
Reliance Elec. & Eng. Co., 1056 Ivanhoe Road, Cleveland, O.
Sprague Electric Works, 527 W. 34th St., New York
Triumph Electric Co., Cincinnati, O.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Convertors, High Speed Steel
Onondaga Steel Co., Inc., Syracuse, N. Y.

Conveyers, Gravity
Caldwell & Son Co., H. W., 17th St. & Western Ave., Chicago, Ill.
Link-Belt Co., Chicago, Ill.

Cotter Pins
Whitman & Barnes Mfg. Co., 1000 West 120th St., Chicago, Ill.

Counterbores
Advance Tool Co., Cincinnati, O.
Billings & Spencer Co., Hartford, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I
Cleveland Twist Drill Co., Cleveland, O.
Detroit Twist Drill Co., Detroit, Mich.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Tool Co., Cleveland, O.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Starrett Co., L. S., Athol, Mass.
Union Twist Drill Co., Athol, Mass.
Windau Tool Co., Cleveland, O.

Countershafts, Friction, Etc.
Bardons & Oliver, Cleveland, O.
Brown Clutch Co., Sandusky, O.
Brown Co., A. & F., 79 Barclay St., New York.
Brown & Sharpe Mfg. Co., Providence, R. I.
Builders Iron Foundry, Providence, R. I.
Cresson-Morris Co., Philadelphia, Pa.
Dalton Manufacturing Corporation, 1911 Park Ave., New York.
Diamond Mch. Co., Providence, R. I.
Garvin Mch. Co., Spring and Varick Sts., New York.
Gisholt Machine Co., Madison, Wis.
Hyatt Roller Bearing Co., Newark, N. J.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Safety Emery Wheel Co., Springfield, O.

Counters, Revolution
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Grant Mfg. & Mch. Co., N. W. Station, Bridgeport, Conn.
Starrett Co., L. S., Athol, Mass.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

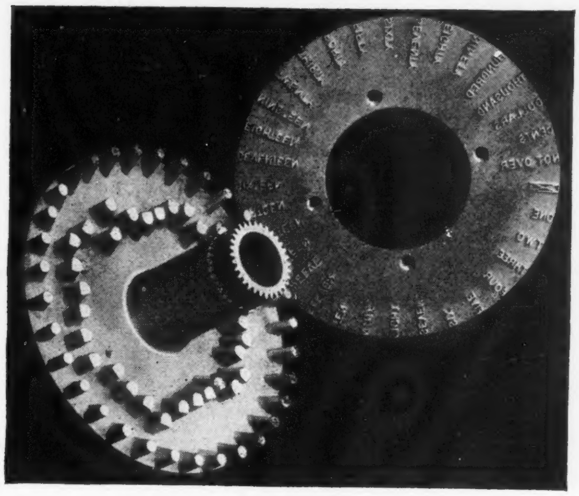
Counting Machines
National Counting Mch. Co., Chicopee Falls, Mass.
National Scale Co., Chicopee Falls, Mass.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Couplers, Hose
Greene, Tweed & Co., 109 Duane St., New York.
Ingersoll-Rand Co., 11 Broadway, New York.

Couplings, Pipe
Dart Mfg. Co., E. M., Providence, R. I.
National Tube Co., Pittsburgh, Pa.

Couplings, Shaft
Brown Clutch Co., Sandusky, O.
Brown Co., A. & F., 79 Barclay St., New York.
Brown Engineering Co., 133 N. 3d St., Reading, Pa.
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Cresson-Morris Co., Philadelphia, Pa.
Link-Belt Company, Chicago, Ill.
Moore & White Co., 2707-2737 N. 15th St., Philadelphia, Pa.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.
Royersford Foundry & Mch. Co., 54 N. 5th St., Philadelphia, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Smith-Serrell Co., Inc., 144-A Cedar St., New York.
Wood Sons Co., T. B., Chambersburg, Pa.

Cranes
Box & Co., Alfred, Philadelphia, Pa.
Curtis Pneumatic Mchy. Co., 1568 Kienlen Ave., St. Louis, Mo.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Niles-Bement-Pond Co., 111 Broadway, New York.
Northern Engineering Works, Detroit, Mich.
Shaw Electric Crane Co., Muskegon, Mich.
Toledo Bridge & Crane Co., Toledo, O.
Vandyck Churchill Co., 149 Broadway, New York.
Wright Mfg. Co., Lisbon, O.
Yale & Towne Mfg. Co., 9 E. 40th St., New York.



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Canton Fdry. & Mch. Co., Canton, O.

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LeBlond Mch. & Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pedrick Tool & Mch. Co., 3639 N. Lawrence St., Philadelphia, Pa.
Underwood & Co., H. B., Philadelphia, Pa.

Crucibles
Dixon Crucible Co., Joseph, Jersey City, N. J.

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Adams Co., Dubuque, Iowa.
Advance Tool Co., Cincinnati, O.
Barber-Colman Co., Rockford, Ill.
Becker Milling Mch. Co., Hyde Park, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cleveland Milling Mch. Co., Cleveland, O.
Cleveland Twist Drill Co., Cleveland, O.
Detroit Twist Drill Co., Detroit, Mich.
Goddard Tool Co., Chicago, Ill.
Gould & Eberhardt, Newark, N. J.
Harris Engineering Co., H. E., Bridgeport, Conn.
Illinois Tool Works, Chicago, Ill.
Ingersoll Milling Machine Co., Rockford, Ill.
Kearney & Trecker Co., Milwaukee, Wis.
Krasberg Mfg. Co., 412 Orleans St., Chicago, Ill.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Michigan Tool Co., Detroit, Mich.
National Tool Co., Cleveland, O.
National Twist Drill & Tool Co., Detroit, Mich.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Reliance Steel & Tool Co., Inc., 30 Church St., New York.
Standard Tool Co., Cleveland, O.
T. C. M. Mfg. Co., Harrison, N. J.
Union Twist Drill Co., Athol, Mass.
Whitney Mfg. Co., Hartford, Conn.
Windau Tool Co., Cleveland, O.

Cutting Compound
See Compound, Cutting, Grinding, etc.

Cutting-off Machines, Abrasive Wheel
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Nutter & Barnes Co., Hinsdale, N. H.
Peter Bros. Mfg. Co., Algonquin, Ill.

Cutting-off Machines, Cold Saw
See Saws, Rotary Machines.

Cutting-off Machines, Rotary
Brown & Sharpe Mfg. Co., Providence, R. I.
Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn.
Davis Mch. Tool Co., Inc., Rochester, N. Y.
Etna Mch. Tool Co., Toledo, O.
Fawcus Mch. Co., Pittsburgh, Pa.
Hurlbut, Rogers Mchy. Co., So. Sudbury, Mass.
Modern Mch. Tool Co., Jackson, Mich.
Treadwell Engineering Co., Easton, Pa.

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Western Tool & Mfg. Co., Springfield, O.

Cyclometers
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Cylinder Borers
See Boring and Drilling Machines, Vertical.
Beaman & Smith Co., Providence, R. I.
Underwood & Co., H. B., Philadelphia, Pa.

Cylinder Boring Machines, Portable
Pedrick Tool & Mch. Co., 3639 N. Lawrence St., Philadelphia, Pa.

Demagnetizers
D & W Fuse Co., Providence, R. I.
Heald Mch. Co., 20 New Bond St., Worcester, Mass.
Walker Co., O. S., Worcester, Mass.

Die Blocks
Dyson & Sons, Jos., Cleveland, O.

Die Castings
See Castings, Die or Die-molded.

Die Milling Machines
Anderson Die Machine Co., Bridgeport, Conn.
Billings & Spencer Co., Hartford, Conn.

Die Sinking Machines
Jackson Mch. Tool Co., Jackson, Mich.
Pratt & Whitney Co., Hartford, Conn.
Walcott Lathe Co., Jackson, Mich.

Die Stocks
Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn.
Bay State Tap & Die Co., Mansfield, Mass.
Billings & Spencer Co., Hartford, Conn.
Brubaker & Bros., W. L., Millersburg, Pa.
Butterfield & Co., Derby Line, Vermont.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Curtis & Curtis Co., Bridgeport, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hart Mfg. Co., E. 20th St. and Marion Ave., Cleveland, O.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
Reed Mfg. Co., Erie, Pa.
Saunders Sons, D., Yonkers, N. Y.
Standard Engineering Co., Ellwood City, Pa.
Walworth Mfg. Co., Boston, Mass.
Wells & Son Co., F. E., Greenfield, Mass.

Dies, Lettering and Embossing
Matthews & Co., Jas. H., 3946 Forbes Field, Pittsburgh, Pa.
Maute & Sons, J., Buffalo, N. Y.
Noble & Westbrook Mfg. Co., Hartford, Conn.
Schwerdtle Stamp Co., Bridgeport, Conn.

Dies, Sheet Metal, Etc.
Acklin Stamping Co., 1657 Dorr St., Toledo, O.
American Mch. & Foundry Co., 5520 2nd Ave., Brooklyn, N. Y.
American Tool & Mfg. Co., Urbana, O.
Automat Tool Works, 252 Greenwich St., New York.
Bliss Co., E. W., 5 Adams St., Brooklyn, N. Y.
Cleveland Mch. & Mfg. Co., 4944 Hamilton Ave., Cleveland, O.
Columbus Die, Tool & Mch. Co., Columbus, O.
Ferracute Mch. Co., Bridgeton, N. J.
Goddard Tool Co., Chicago, Ill.
Harris Engineering Co., H. E., Bridgeport, Conn.
Krasberg Mfg. Co., 412 Orleans St., Chicago, Ill.
Lansing Stamping & Tool Co., Lansing, Mich.
Marvin Mfg. Co., W. B., Urbana, O.
Maute & Sons, J., Buffalo, N. Y.
Mehl Mch. Tool & Die Co., Roselle, N. J.
Michigan Tool Co., Detroit, Mich.
Middlesex Mch. Wks., Middletown, Conn.
Modern Tool, Die & Machine Co., Columbus, O.
Moore-Eastwood Mfg. Co., Dayton, O.
Nelson Tool Co., Inc., 781-783 E. 142nd St., New York.
Pratt & Whitney Co., Hartford, Conn.
Rockford Metal Specialty Co., Rockford, Ill.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Slocum, Avram & Slocum Laboratories, Inc., 531 W. 21st St., New York.
Solar Metal Products Co., Inc., Columbus, O.
Swaine Mfg. Co., F. J., St. Louis, Mo.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Taylor-Shantz Co., Rochester, N. Y.
Ulmer Co., J. C., Cleveland, O.
Urbana Tool & Die Co., Urbana, O.
Waltham Machine Works, Waltham, Mass.

Dies, Threading, Opening
Butterfield & Co., Derby Line, Vt.
Errington Mechanical Laboratory, 39 Cortlandt St., New York.
Geometric Tool Co., New Haven, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Ideal Tool & Mfg. Co., Beaver Falls, Pa.
Jones & Lamson Mch. Co., Springfield, Vt.
Landis Mch. Co., Inc., Waynesboro, Pa.
Modern Tool Co., 2nd and State Sts., Erie Pa.
Murchey Mch. & Tool Co., 34 Porter St., Detroit, Mich.
National Acme Co., Cleveland, O.
Pratt & Whitney Co., Hartford, Conn.
Rickert-Shafer Co., Erie, Pa.

Drafting Machines
Keuffel & Esser Co., Hoboken, N. J.

Draw Benches
Roux & Heyberger, 108 Rue Lafayette, Paris, France.

Drawing Boards and Tables
Economy Drawing Table Co., Toledo, O.
Keuffel & Esser Co., Hoboken, N. J.
New Britain Mch. Co., New Britain, Conn.

Drawing Materials
Keuffel & Esser Co., Hoboken, N. J.

Dressers, Grinding Wheel
Abrasive Co., Bridesburg, Philadelphia, Pa.
American Emery Wheel Works, Providence, R. I.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Calder, Geo. H., Lancaster, Pa.
Desmond-Stephan Mfg. Co., Urbana, O.
Hetherington-McCabe Co., Piqua, O.
Norton Co., Worcester, Mass.
Reed Mfg. Co., Erie, Pa.
Safety Emery Wheel Co., Springfield, O.
Standard Tool Co., Cleveland, O.
Sterling Grinding Wheel Co., Tiffin, O.
Vitrified Wheel Co., Westfield, Mass.
Western Tool & Mfg. Co., Springfield, O.

Drill Heads, Multiple
Baush Mch. Tool Co., 200 Wason Ave., Springfield, Mass.
Covington Multiple Drill Co., Cincinnati, O.
Medina Mch. Co., Medina, O.
National Automatic Tool Co., Richmond, Ind.
Newman Mfg. Co., Cincinnati, O.
Rockford Drilling Mch. Co., Rockford, Ill.
Sellew Mch. Tool Co., Pawtucket, R. I.

Drill Sockets
Cleveland Twist Drill Co., Cleveland, O.
Detroit Twist Drill Co., Detroit, Mich.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Scully-Jones & Co., 647 Railway Exchange Bldg., Chicago, Ill.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.

Drill Speeders
Graham Mfg. Co., Providence, R. I.
Peter Bros. Mfg. Co., 135 Railroad Ave., Algonquin, Ill.

Drill Stands
Cleveland Twist Drill Co., Cleveland, O.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Standard Tool Co., Cleveland, O.

Drilling Machines, Automatic
Baker Bros., Toledo, O.

Drilling Machines, Bench
Ames Co., B. C., Waltham, Mass.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Blomquist-Eck Mch. Co., Cleveland, O.
Buffalo Forge Co., Buffalo, N. Y.
Canedy-Otto Mfg. Co., Chicago Heights, Ill.
Hisey-Wolf Mch. Co., Cincinnati, O.
Langelier Mfg. Co., Providence, R. I.
Leland-Gifford Co., Worcester, Mass.
National Automatic Tool Co., Richmond, Ind.
Pratt & Whitney Co., Hartford, Conn.
Reed Co., Francis, 43 Hammond St., Worcester, Mass.
Rockford Drilling Mch. Co., Rockford, Ill.
Taylor & Fenn Co., Hartford, Conn.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.

Drilling Machines, Boiler
Cincinnati Bickford Tool Co., Oakley, Cincinnati, O.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Drilling Machines, Portable Electric
Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill.
Cincinnati Electrical Tool Co., Cincinnati, O.
Clark Electric Co., Inc., Jas., Jr., Louisville, Ky.
Errington Mechanical Laboratory, 39 Cortlandt St., New York.
Hisey-Wolf Mch. Co., Cincinnati, O.
Independent Pneumatic Tool Co., Chicago, Ill.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Neil & Smith Elec. Tool Co., Cincinnati, O.
Standard Electric Tool Co., Cincinnati, O.
Stow Mfg. Co., Binghamton, N. Y.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.
Van Dorn Electric Tool Co., Cleveland, O.

Drilling Machines, Horizontal, Duplex
Garvin Mch. Co., Spring and Varick Sts., New York.
Langelier Mfg. Co., Providence, R. I.

Drilling Machines, Multiple Spindle, Adjustable
Baush Mch. Tool Co., 200 Wason Ave., Springfield, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Langelier Mfg. Co., Providence, R. I.
National Automatic Tool Co., Richmond, Ind.
Pratt & Whitney Co., Hartford, Conn.

Drilling Machines, Multiple Spindle, Horizontal
Baush Mch. Tool Co., 200 Wason Ave., Springfield, Mass.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Langelier Mfg. Co., Providence, R. I.
Moline Tool Co., Moline, Ill.
National Acme Co., Cleveland, O.

Drilling Machines, Multiple Spindle, Turret
Langelier Mfg. Co., Providence, R. I.
National Automatic Tool Co., Richmond, Ind.
Newman Mfg. Co., Cincinnati, O.
Quint, A. E., Hartford, Conn.
Turner Mch. Co., Danbury, Conn.

Drilling Machines, Multiple Spindle, Vertical
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Barnes Drill Co., Inc., 814 Chestnut St., Rockford, Ill.
Cincinnati Bickford Tool Co., Oakley, Cincinnati, O.
Cincinnati Pulley Mchy. Co., Cincinnati, O.
Clark Electric Co., Inc., Jas., Jr., Louisville, Ky.
Colburn Mch. Tool Co., Franklin, Pa.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Henry & Wright Mfg. Co., Hartford, Conn.
Langelier Mfg. Co., Providence, R. I.
Leland-Gifford Co., Worcester, Mass.
Medina Mch. Co., Medina, O.
Moline Tool Co., Moline, Ill.
National Automatic Tool Co., Richmond, Ind.
Newton Mch. Tool Wks., Inc., 23rd and Vine Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Pratt & Whitney Co., Hartford, Conn.
Quint, A. E., Hartford, Conn.
Reed Co., Francis, 43 Hammond St., Worcester, Mass.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.
Rockford Drilling Mch. Co., Rockford, Ill.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Silver Mfg. Co., Salem, O.
Sipp Mch. Co., Paterson, N. J.
Taylor & Fenn Co., Hartford, Conn.
Taylor Mch. Co., Cleveland, O.

Drilling Machines, Pneumatic
Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York.

Drilling Machines, Radial
American Tool Works Co., Cincinnati, O.
Canedy-Otto Mfg. Co., Chicago Heights, Ill.
Carlton Mch. Tool Co., Cincinnati, O.
Cincinnati Bickford Tool Co., Oakley, Cincinnati, O.
Dresses Mch. Tool Co., Cincinnati, O.
Fosdick Mch. Tool Co., Cincinnati, O.
Hammond Mfg. Co., Cleveland, O.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Morris Mch. Tool Co., Cincinnati, O.
Mueller Mch. Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., 111 Broadway, New York.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.
Roux & Heyberger, 108 Rue Lafayette, Paris, France.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Taylor & Fenn Co., Hartford, Conn.

Drilling Machines, Rail
Colburn Mch. Tool Co., Franklin, Pa.
Foote-Burt Co., Cleveland, O.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Moline Tool Co., Moline, Ill.
Newton Mch. Tool Wks., Inc., 23rd and Vine Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Taylor & Fenn Co., Hartford, Conn.

Drilling Machines, Sensitive
Albany Hardware Specialty Mfg. Co., Albany, Wis.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Bilton Mch. Tool Co., Bridgeport, Conn.
Cincinnati Pulley Mchy. Co., Cincinnati, O.
De Mooy Mch. Co., Cleveland, O.
Gardam & Son, Inc., Wm., 108 Park Place, New York.
Hammond Mfg. Co., Cleveland, O.
Henry & Wright Mfg. Co., Hartford, Conn.
Johnson Mch. Tool Co., Gouverneur, N. Y.
Langelier Mfg. Co., Providence, R. I.
Leland-Gifford Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Reed Co., Francis, 43 Hammond St., Worcester, Mass.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.
Royersford Foundry & Mch. Co., 54 N. 5th St., Philadelphia, Pa.
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Aurora Tool Works, Aurora, Ind.
Baker Bros., Toledo, O.
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National Twist Drill & Tool Co., Detroit, Mich.
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Emery Wheel Dressers
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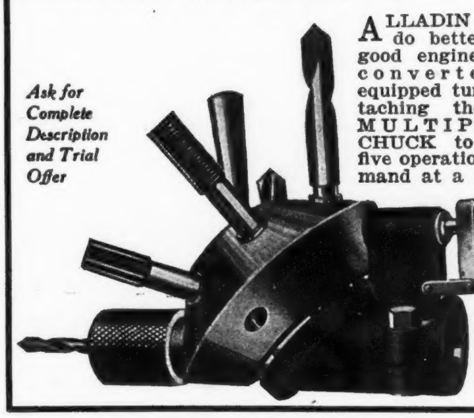

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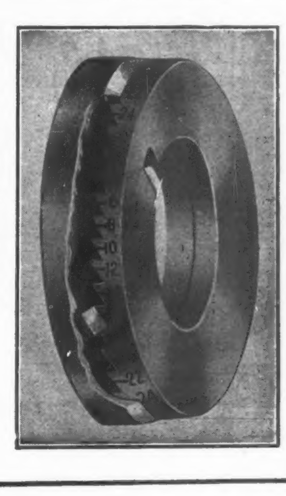

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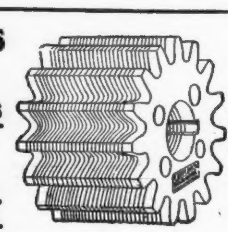

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Bryant Chucking Grinder Co., Springfield, Vt.

Grinding Machines, Cutter
Becker Milling Mch. Co., Hyde Park, Mass.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Cincinnati Milling Mch. Co., Oakley, Cincinnati, O.
Garvin Mch. Co., Spring and Varick Sts., New York.
Gould & Eberhardt, Newark, N. J.
Grand Rapids Grinding Mch. Co., Grand Rapids, Mich.
Greenfield Mch. Co., Greenfield, Mass.
Harris Engineering Co., H. E., Bridgeport, Conn.
Ingersoll Milling Mch. Co., Rockford, Ill.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Norton Grinding Co., Worcester, Mass.
Nutter & Barnes Co., Hinsdale, N. H.
Oesterlein Mch. Co., Cincinnati, O.
Pratt & Whitney Co., Hartford, Conn.
Simmons Mch. Co., 1001 Singer Bldg., New York.
Union Twist Drill Co., Athol, Mass.
United States Electrical Tool Co., 6th ave. and Mt. Hope St., Cincinnati, O.
Waltham Mch. Works, Waltham, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Wilmarth & Morman Co., 2180 Monroe Ave., N. W., Grand Rapids, Mich.

Grinding Machines, Cylindrical, Plain
Brown & Sharpe Mfg. Co., Providence, R. I.
Fitchburg Grinding Mch. Co., Fitchburg, Mass.
Greenfield Mch. Co., Greenfield, Mass.
Landis Tool Co., Waynesboro, Pa.
McDonough Mfg. Co., Eau Claire, Wis.
Middlesex Mch. Works, Middletown, Conn.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Norton Grinding Co., Worcester, Mass.
Ott Grinder Co., Indianapolis, Ind.
Pratt & Whitney Co., Hartford, Conn.

Grinding Machines, Cylindrical, Universal
Brown & Sharpe Mfg. Co., Providence, R. I.
Fitchburg Grinding Mch. Co., Fitchburg, Mass.
Fraser Co., Warren F., Boston, Mass.
Grand Rapids Grinding Mch. Co., Grand Rapids, Mich.
Greenfield Mch. Co., Greenfield, Mass.
Landis Tool Co., Waynesboro, Pa.
McDonough Mfg. Co., Eau Claire, Wis.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Ott Grinder Co., Indianapolis, Ind.
Pratt & Whitney Co., Hartford, Conn.
Thompson Grinder Co., Springfield, O.

Grinding Machines, Disc
Besly & Co., Chas. H., 120-B N. Clinton St., Chicago, Ill.
Bickford Mch. Co., Greenfield, Mass.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Diamond Mch. Co., Providence, R. I.
Gardner Mch. Co., Beloit, Wis.
Ransom Mfg. Co., Oshkosh, Wis.
Rowbottom Mch. Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.
Sellew Mch. Tool Co., Pawtucket, R. I.

Grinding Machines, Drill
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Grand Rapids Grinding Mch. Co., Grand Rapids, Mich.
Heald Machine Co., 20 New Bond St., Worcester, Mass.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Standard Tool Co., Cleveland, O.
Sterling Grinding Wheel Co., Tiffin, O.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.
Wilmarth & Morman Co., 2180 Monroe Ave., N. W., Grand Rapids, Mich.

Grinding Machines, Portable Electric
Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill.
Cincinnati Elec. Tool Co., Cincinnati, O.
Clark Elec. Co., Inc., Jas. Jr., Louisville, Ky.
Diamond Mch. Co., Providence, R. I.
Dillon Electric Co., Canton, O.
Forbes & Myers, 178 Union St., Worcester, Mass.
General Electric Co., Schenectady, N. Y.
Hisey-Wolf Mch. Co., Cincinnati, O.
Independent Pneumatic Tool Co., Chicago, Ill.
Neil & Smith Elec. Tool Co., Cincinnati, O.
Slocum, Avram & Slocum Laboratories, Inc., 531 W. 21st St., New York.
Standard Electric Tool Co., Cincinnati, O.
Stow Mfg. Co., Binghamton, N. Y.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.
Van Dorn Electric Tool Co., Cleveland, O.
Wisconsin Elec. Co., Racine, Wis.

Grinding Machines, Gage
Steel Products Engineering Co., Springfield, O.

Grinding Machines, Internal
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Brown & Sharpe Mfg. Co., Providence, R. I.
Bryant Chucking Grinder Co., Springfield, Vt.
Cincinnati Elec. Tool Co., Cincinnati, O.
Fraser Co., Warren F., Boston, Mass.
Greenfield Machine Co., Greenfield, Mass.
Heald Machine Co., 20 New Bond St., Worcester, Mass.
Landis Tool Co., Waynesboro, Pa.
Lansing Stamping & Tool Co., Lansing, Mich.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Ott Grinder Co., Indianapolis, Ind.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Schmidt Co., B. L., Davenport, Iowa.
Slocum, Avram & Slocum Laboratories, Inc., 531 W. 21st St., New York.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.
Van Norman Machine Tool Co., Waltham Ave., Springfield, Mass.
Wood & Safford Mch. Wks., Great Falls, Montana.

Grinding Machines, Knife
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Diamond Mch. Co., Providence, R. I.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Safety Emery Wheel Co., Springfield, O.

Grinding Machines, Motor-Driven, Non-Portable
Dillon Electric Co., Canton, O.
Ransom Mfg. Co., Oshkosh, Wis.

Grinding Machines, Multiple Spindle
Bryant Chucking Grinder Co., Springfield, Vt.

Grinding Machines, Pipe Threading Die
Bignall & Keeler Mch. Works, Edwardsville, Ill.
Landis Mch. Co., Inc., Waynesboro, Pa.
National Mchy. Co., Tiffin, O.

Grinding Machines, Piston Ring
Heald Machine Co., 20 New Bond St., Worcester, Mass.
Pedrick Tool & Mch. Co., 3639 N. Lawrence St., Philadelphia, Pa.
Walker Co., O. S., Worcester, Mass.

Grinding Machines, Radial, Ball Race, Etc.
Rivett Lathe & Grinding Co., Brighton, Boston, Mass.
Van Norman Machine Tool Co., Waltham Ave., Springfield, Mass.

Grinding Machines, Rotary Surface
Heald Machine Co., 20 New Bond St., Worcester, Mass.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Persons-Arter Mch. Co., Worcester, Mass.

Grinding Machines, Surface
Blake & Johnson Co., Waterbury, Conn.
Blanchard Machine Co., 64 State St., Cambridge, Mass.
Boston Scale & Machine Co., Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Diamond Machine Co., Providence, R. I.
Fraser Co., Warren F., Boston, Mass.
Garvin Mch. Co., Spring and Varick Sts., New York.
Heald Machine Co., 20 New Bond St., Worcester, Mass.
Middlesex Mch. Works, Middletown, Conn.
New Jersey Mchy. Exchange, Newark, N. J.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Norton Grinding Co., Worcester, Mass.
Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.
Rowbottom Machine Co., Waterbury, Conn.
Safety Emery Wheel Co., Springfield, O.
Walker Co., O. S., Worcester, Mass.
Walls Tool Co., T. P., 75 Walker St., New York.
Wilmarth & Morman Co., 2180 Monroe Ave., N. W., Grand Rapids, Mich.

Grinding Machines, Tool and Cutter
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Baird Mch. Co., Bridgeport, Conn.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Blake & Johnson Co. Waterbury, Conn.
Blount Co., J. G., Everett, Mass.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Brown & Sharpe Mfg. Co. Providence, R. I.
Cincinnati Elec. Tool Co., Cincinnati, O.
Cincinnati Milling Mch. Co., Oakley, Cincinnati, O.
Diamond Mch. Co., Providence, R. I.
Factory & Mill Supply Co., Boston, Mass.
Forbes & Myers, 178 Union St., Worcester, Mass.
Gisholt Mch. Co., Madison, Wis.
Grand Rapids Grinding Mch. Co., Grand Rapids, Mich.
Greenfield Machine Co., Greenfield, Mass.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
McDonough Mfg. Co., Eau Claire, Wis.
Meisselbach-Catucci Mfg. Co., 27 Congress St., Newark, N. J.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Newark Gear Cutting Mch. Co., Newark, N. J.
Norton Grinding Co., Worcester, Mass.
Nutter & Barnes Co., Hinsdale, N. H.
Oesterlein Mch. Co., Cincinnati, O.
Ott Grinder Co., Indianapolis, Ind.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Simmons Mch. Co., 1001 Singer Bldg., New York.
Standard Tool Co., Cleveland, O.
Taylor & Fenn Co., Hartford, Conn.
United States Electrical Tool Co., 6th Ave. and Mt. Hope St., Cincinnati, O.
Vitrified Wheel Co., Westfield, Mass.
Walker Co., O. S., Worcester, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Conn.
Wilmarth & Morman Co., 2180 Monroe Ave., N. W., Grand Rapids, Mich.
Wisconsin Elec. Co., Racine, Wis.

Grinding Machines, Universal, Lathe and Planer Tools
Gisholt Machine Co., Madison, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Grinding Wheels
Abrasive Co., Bridesburg, Philadelphia, Pa.
American Emery Wheel Works, Providence, R. I.
Bridgeport Safety Emery Wheel Co., Inc., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Detroit Grinding Wheel Co., Detroit, Mich.
Norton Co., Worcester, Mass.
Safety Emery Wheel Co., Springfield, O.
Springfield Grinding Co., Chester, Mass.
Star Corundum Wheel Co., Detroit, Mich.
Sterling Grinding Wheel Co., Tiffin, O.
Vitrified Wheel Co., Westfield, Mass.

Hammers, Drop
Billings & Spencer Co., Hartford, Conn.
Bliss Co., E. W., 5 Adams St., Brooklyn, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Erie Foundry Co., Erie, Pa.
Miner & Peck Mfg. Co., New Haven, Conn.
Niles-Bement-Pond Co., 111 Broadway, New York.
Williams, White & Co., Moline, Ill.

Hammers, Pneumatic
Erie Foundry Co., Erie, Pa.
Independent Pneumatic Tool Co., Chicago, Ill.
Ingersoll-Rand Co., 11 Broadway, New York.
Nazel Engineering Works, 4043 N. 5th St., Philadelphia, Pa.

Hammers, Power
Beaudry & Co., Inc., Boston, Mass.
Bradley & Son., Inc., C. C., Syracuse, N. Y.
Buffalo Foundry & Mch. Co., 10 Winchester Ave., Buffalo, N. Y.
Dienelt & Eisenhardt, Inc., Philadelphia, Pa.
Erie Foundry Co., Erie, Pa.
Mayer Bros. Co., 131 Rock St., Mankato, Minn.
Nazel Engineering Works, 4043 N. 5th St., Philadelphia, Pa.
West Tire Setter Co., Rochester, N. Y.
Williams, White & Co., Moline, Ill.

Hammers, Steam
Buffalo Foundry & Mch. Co., 10 Winchester Ave., Buffalo, N. Y.
Chambersburg Engineering Co., Chambersburg, Pa.
Erie Foundry Co., Erie, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Handles, Machine
Cincinnati Ball Crank Co., Cincinnati, O.
Cincinnati Screw Co., Cincinnati, O.

Hangers, Shaft
Brown & Sharpe Mfg. Co., Providence, R. I.
Brown Co., A. & F., 79 Barclay St., New York.
Cresson-Morris Co., Philadelphia, Pa.
Fafnir Bearing Co., New Britain, Conn.
Hess-Bright Mfg. Co., Front St. and Erie Ave., Philadelphia, Pa.
Hyatt Roller Bearing Co., Newark, N. J.
Link-Belt Company, Chicago, Ill.
New Departure Mfg. Co., Bristol, Conn.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia, Pa.
Sellers & Co., Inc., Wm., Philadelphia, Pa.
S K F Ball Bearing Co., Hartford, Conn.
Standard Pressed Steel Co., Philadelphia, Pa.
Wood Sons Co., T. B., Chambersburg, Pa.

Hardness Testing Instruments
Shore Instrument & Mfg. Co., Inc., 557 W. 22nd St., New York

Heating and Ventilating Apparatus
Buffalo Forge Co., Buffalo, N. Y.

Hobbing Machines
See Gear Cutting Machines, Helical and Spur (Hob) and Gear Cutting Machines, Worms and Worm Wheels (Hob).

Hobs
Adams Co., Dubuque, Iowa.
Barber-Colman Co., Rockford, Ill.
Brown & Sharpe Mfg. Co., Providence, R. I.
Goddard Tool Co., Chicago, Ill.
Gould & Eberhardt, Newark, N. J.
Illinois Tool Works, Chicago, Ill.
Lees-Bradner Co., Cleveland, O.
Meisselbach-Catucci Mfg. Co., 27 Congress St., Newark, N. J.
Michigan Tool Co., Detroit, Mich.
Union Twist Drill Co., Athol, Mass.

Hoisting and Conveying Machinery
Caldwell & Son, Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Link-Belt Company, Chicago, Ill.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Wright Mfg. Co., Lisbon, O.
Yale & Towne Mfg. Co., 9 E. 40th St., New York.

Hoists, Air
Ingersoll-Rand Co., 11 Broadway, New York.
Northern Engineering Works, Detroit, Mich.

Hoists, Chain, Etc.
Box & Co., Alfred, Philadelphia, Pa.
Ford Chain Block & Mfg. Co., Philadelphia, Pa.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Mason & Co., Inc., Volney W., Providence, R. I.
Wright Mfg. Co., Lisbon, O.
Yale & Towne Mfg. Co., 9 E. 40th St., New York.

Hoists, Electric
Box & Co., Alfred, Philadelphia, Pa.
Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill.
General Electric Co., Schenectady, N. Y.
Link-Belt Company, Chicago, Ill.
Northern Engineering Works, Detroit, Mich.
Sprague Electric Works, 527 W. 34th St., New York.
Thomas Elevator Co., 22 S. Hoyne Ave., Chicago, Ill.
Toledo Bridge & Crane Co., Toledo, O.
Yale & Towne Mfg. Co., 9 E. 40th St., New York.

Hoists, Pneumatic
Chicago Pneumatic Tool Co., 1060 Fisher Bldg., Chicago, Ill.
Curtis Pneumatic Mchy. Co., 1568 Kienlen Ave., St. Louis, Mo.
Ingersoll-Rand Co., 11 Broadway, New York.
Northern Engineering Works, Detroit, Mich.

Hoists, Portable
Brown Clutch Co., Sandusky, O.
Canton Foundry & Machine Co., Canton, O.

Horses, Steel
Frasse & Co., Inc., Peter A., 417 Canal St. New York.

Hydraulic Machinery and Tools
Bethlehem Steel Co., South Bethlehem, Pa.
Chambersburg Engineering Co., Chambersburg, Pa.
Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, O.
Metalwood Mfg. Co., Detroit, Mich.
Watson-Stillman Co., 192 Fulton St., New York.
Williams, White & Co., Moline, Ill.

Indicators, Speed
Brown & Sharpe Mfg. Co., Providence, R. I.
Brown Instrument Co., Philadelphia, Pa.
Goodell-Pratt Co., Greenfield, Mass.
Greene, Tweed & Co., 109 Duane St., New York.
Johnson & Miller, 42 Murray St., New York.
Starrett Co., L. S., Athol, Mass.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Indicators, Test
Brown & Sharpe Mfg. Co., Providence, R. I.
Brown Instrument Co., Philadelphia, Pa.
Johnson & Miller, 42 Murray St., New York.
Norton Grinding Co., Worcester, Mass.
Slocum, Avram & Slocum Laboratories, Inc., 531 W. 21st St., New York
Starrett Co., L. S., Athol, Mass.

Injectors, Steam
Sellers & Co., Inc., Wm., Philadelphia, Pa.
Walworth Mfg. Co., Boston, Mass.

Jacks, Hydraulic
Watson-Stillman Co., 192 Fulton St., New York.

Jacks, Planer
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.

Jigs and Fixtures
American Mch. & Foundry Co., 5520 2nd Ave., Brooklyn, N. Y.
American Tool & Mfg. Co., Urbana, O.
Automat Tool Works, 252 Greenwich St., New York.
Becker Milling Mch. Co., Hyde Park, Mass.
Columbus Die, Tool & Mch. Co., Columbus, O.
Fox Gun Co., A. H., Philadelphia, Pa.
Gardam & Son, Inc., Wm., 108 Park Place, New York.
Gisholt Mch. Co., Madison, Wis.
Goddard Tool Co., Chicago, Ill.
Harris Engineering Co., H. E., Bridgeport, Conn.
Krasberg Mfg. Co., 412 Orleans St., Chicago, Ill.
Lansing Stamping & Tool Co., Lansing, Mich.
Maute & Sons, J., Buffalo, N. Y.
Mehl Mch. Tool & Die Co., Roselle, N. J.
Michigan Tool Co., Detroit, Mich.
Middlesex Machine Works, Middletown, Conn.
Modern Tool, Die & Machine Co., Columbus, O.
Moore-Eastwood Mfg. Co., Dayton, O.
Nelson Tool Co., 781-783 E 152nd St., New York.
North Side Tool Works, Dayton, O.
Off-Set Tool Co., Bridgeport, Conn.
Ohmer Fare Register Co., Dayton, O.
Reynolds Pattern & Mch. Co., Massillon, O.
Slocum, Avram & Slocum Laboratories, Inc., 531 W. 21st St., New York
Solar Metal Products Co., Inc., Columbus, O.
S-P Mfg. Co., Cleveland, O.
Steel Products Engineering Co., Springfield, O.
Steiner Bros., Lima, O.
Swedish Gage Co., Inc., 16 W. 61st St., New York.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Taylor-Shantz Co., Rochester, N. Y.
T. C. M. Mfg. Co., Harrison, N. J.
Ulmer Co., J. C., Cleveland, O.
Urbana Tool & Die Co., Urbana, O.
Windau Tool Co., Cleveland, O.

Kettles, Soda
Brown & Sharpe Mfg. Co., Providence, R. I.
Gray & Prior Mch. Co., 38 Suffield St., Hartford, Conn.
Niles-Bement-Pond Co., 111 Broadway, New York.

Keyseaters
Advance Tool Co., Cincinnati, O.
Baker Bros., Toledo, O.
Burr & Son, J. T., 429 Kent Ave., Brooklyn, N. Y.
Davis Mch. Tool Co., Inc., Rochester, N. Y.
Lapointe Mch. Tool Co., Hudson, Mass.
Mitts & Merrill, 843 Water St., Saginaw, Mich.
Morton Mfg. Co., Muskegon Heights, Mich.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.

Keys, Machine
Moltrup Steel Products Co., Beaver Falls, Pa.
Morton Mfg. Co., Muskegon Heights, Mich.
Standard Gauge Steel Co., Beaver Falls, Pa.
Whitney Mfg. Co., Hartford, Conn.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Knives, Machine
Coes Wrench Co., Worcester, Mass.
Simonds Mfg. Co., Fitchburg, Mass.

Knurl Holders
Graham Mfg. Co., Providence, R I.
Pratt & Whitney Co., Hartford, Conn.

Knurling Tools
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
Pratt & Whitney Co., Hartford, Conn.
Wells & Son Co., F. E. Greenfield, Mass.
Williams & Co., J. H., 61 Richard St., Brooklyn, N. Y.

Lamp Brackets, Guards, Etc.
McCrosky Reamer Co., Meadville, Pa.
Newman Mfg. Co., Cincinnati, O.

Lamps, Electric
General Electric Co., Schenectady, N. Y.
Westinghouse Lamp Co., 165 Broadway, New York.

Lapping Machines, Power
Builders Iron Foundry, Providence, R. I.

Lathe Attachments
American Tool Works Co., Cincinnati, O.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Barnes Drill Co., Inc., 814 Chestnut St., Rockford, Ill.
Boye & Emmes Mch. Tool Co., Cincinnati, O.
Bradford Mch. Tool Co., Cincinnati, O.
Bridgeford Mch. Tool Works, 151 Winton Road, Rochester, N. Y.
Carroll-Jamieson Mch. Tool Co., 257 Davis St., Batavia, O.
Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, O
Chard Lathe Co., Newcastle, Ind.
Cincinnati Iron & Steel Co., Cincinnati, O.
Davis Machine Tool Co., Inc., Rochester, N. Y.
Diamond Machine Co., Providence, R. I.
Fitchburg Machine Works, Fitchburg, Mass.
Flather & Co., Inc., Nashua, N. H.
Garvin Mch. Co., Spring and Varick Sts., New York.
Greaves-Klusman Tool Co., Cincinnati, O.
Hendey Mch. Co., Torrington, Conn.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Monarch Mch. Tool Co., Sidney, O.
Mueller Mch. Tool Co., Cincinnati, O.
Newman Mfg. Co., Cincinnati, O.
Niles-Bement-Pond Co., 111 Broadway, New York.
Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich.
Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Rockford Tool Co., Rockford, Ill.
Sebastian Lathe Co., Cincinnati, O.
Seneca Falls Mfg. Co., 330 Fall St., Seneca Falls, N. Y.
Slocum, Avram & Slocum Laboratories, Inc., 531 W. 21st St., New York.
Springfield Mch. Tool Co., 631 Southern Ave., Springfield, O.
Vandyck Churchill Co., 149 Broadway, New York.
Willard Machine Tool Co., Cincinnati, O.
Wood & Safford Machine Works, Great Falls, Montana.

Lathe Dogs
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
Ready Tool Co., Bridgeport, Conn.
Underwood & Co., H. B., Philadelphia, Pa.
Western Tool & Mfg. Co., Springfield, O.
West Steel Casting Co., Cleveland, O.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Lathe, Planer and Shaper Tools
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Chard Lathe Co., Newcastle, Ind.
Gisholt Machine Co., Madison, Wis.
McCrosky Reamer Co., Meadville, Pa.
O. K. Tool Holder Co., Shelton, Conn.
Pratt & Whitney Co., Hartford, Conn.
Ready Tool Co., Bridgeport, Conn.
Sebastian Lathe Co., Cincinnati, O.
Thompson & Son Co., Henry G., New Haven, Conn.
West Haven Mfg. Co., New Haven, Conn.
Western Tool & Mfg. Co., Springfield, O.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Lathes, Automatic
Fitchburg Automatic Mch. Works, Fitchburg, Mass.
Gisholt Mch. Co., Madison, Wis.
Jones & Lamson Mch. Co., Springfield, Vt.
New Britain Mch. Co., New Britain, Conn.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.

Lathes, Automatic Screw Threading
Automatic Machine Co., Bridgeport, Conn.

Lathes, Axle and Shaft
Bridgeford Mch. Tool Works, 151 Winton Road, Rochester, N. Y.
Fitchburg Machine Works, Fitchburg, Mass.
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Lathes, Bench
Ames Co., B. C., Waltham, Mass.
Dalton Manufacturing Corporation, 1911 Park Ave., New York.
Diamond Mch. Co., Providence, R. I.
Elgin Tool Works, Elgin, Ill.
Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill.
Hjorth Lathe & Tool Co., Boston, Mass.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Seneca Falls Mfg. Co., 330 Fall St., Seneca Falls, N. Y.
Sloan & Chace Mfg. Co., Ltd., Newark, N. J.
Van Norman Mch. Tool Co., Springfield, O.
Wade, Walter H., Boston, Mass.
Waltham Mch. Works, Waltham, Mass.
Wells & Son Co., F. E., Greenfield, Mass.

Lathes, Boring
Gisholt Mch. Co., Madison, Wis.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Lathes, Brass Workers'
Acme Machine Tool Co., Cincinnati, O.
Bardons & Oliver, Cleveland, O.
Dreses Mch. Tool Co., Cincinnati, O.
Garvin Mch. Co., Spring and Varick Sts., New York.
Pierce Mch. Tool Co., 617 W. Jackson Blvd., Chicago, Ill.
Springfield Mch. Tool Co., 631 Southern Ave., Springfield, O.
Warner & Swasey Co., Cleveland, O.
Wood Turret Mch. Co., Brazil, Ind.

Lathes, Car Wheel
Manning, Maxwell & Moore, Inc., 119 W. 40th St., New York.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Lathes, Crankshaft
American Tool Works Co., Cincinnati, O.
LeBlond Mch. Tool Co., R. K., Cincinnati, O.
Lodge & Shipley Mch. Tool Co., Cincinnati, O.
Niles-Bement-Pond Co., 111 Broadway, New York.

Lathes, Engine
American Tool Works Co., Cincinnati, O. 14" to 24", inclusive.
Axelson Mch. Co., Los Angeles, Cal. 16" and 18".
Barnes Co., W. F. & John, Rockford, Ill. 9" to 18", inclusive.
Barnes Drill Co., Inc., Rockford, Ill. 14-24" and 22-36" gap.
Bosworth, W. H., Cleveland, O. 16".
Boye & Emmes Mch. Tool Co., Cincinnati, O. 18" to 48", inclusive.
Bradford Mch. Tool Co., Cincinnati, O. 14" to 42", inclusive.
Bridgeford Mch. Tool Works, 151 Winton Road, Rochester, N. Y. 26" to 48", inclusive.
Carroll-Jamieson Mch. Tool Co., 257 Davis St., Batavia, O., 13" and 14".
Champion Tool Works Co., 2422 Spring Grove Ave., Cincinnati, O. 12" to 18", inclusive.
Chard Lathe Co., Newcastle, Ind. 16" to 28", incl.
Cincinnati Iron & Steel Co., Cincinnati, O. 14" to 24", inclusive.
Cincinnati Lathe & Tool Co., Oakley, Cincinnati, O., 16" to 22", incl.
Dalton Manufacturing Corporation, 1911 Park Ave., New York, 6" to 18" inclusive.
Davis Mch. Tool Co., Inc., Rochester, N. Y. 12" to 42", inclusive.
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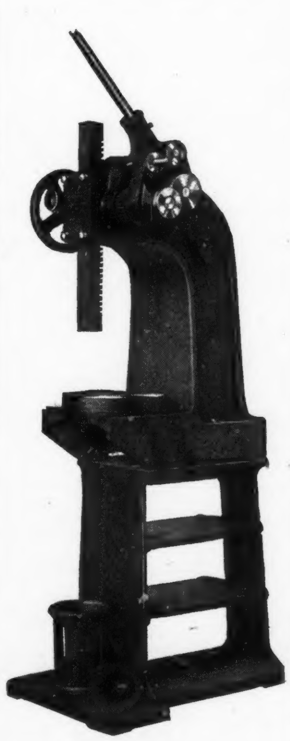

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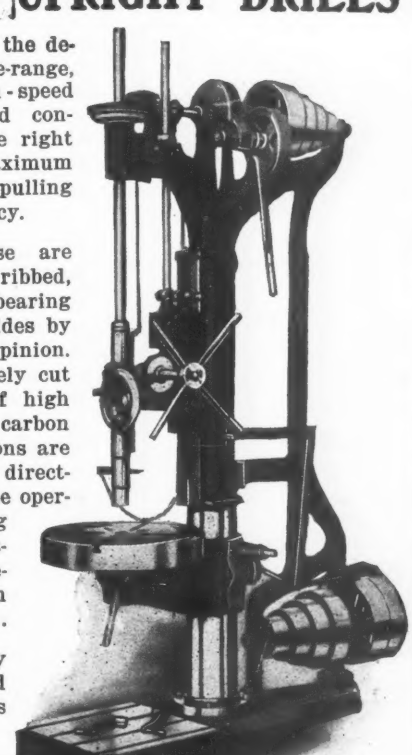

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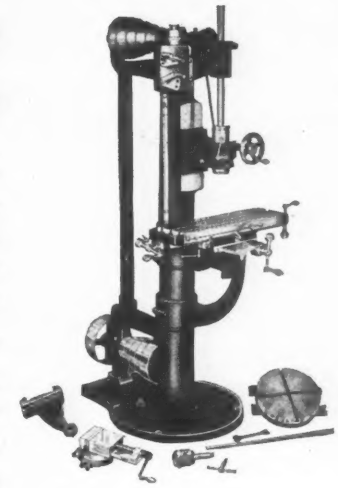

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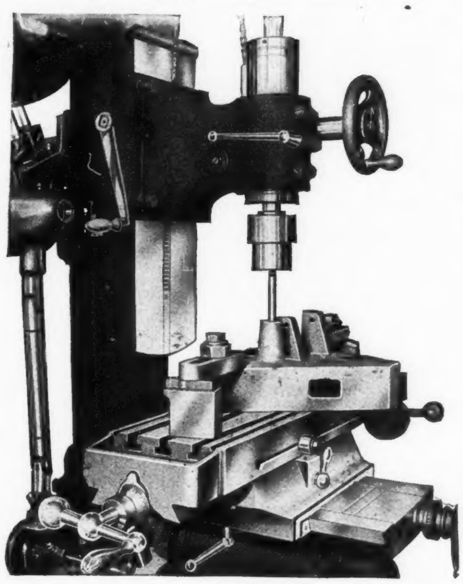

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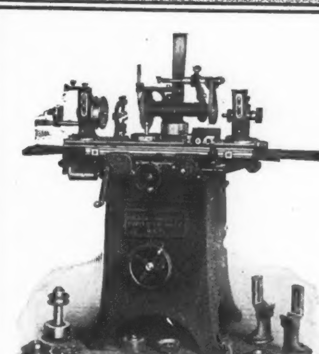

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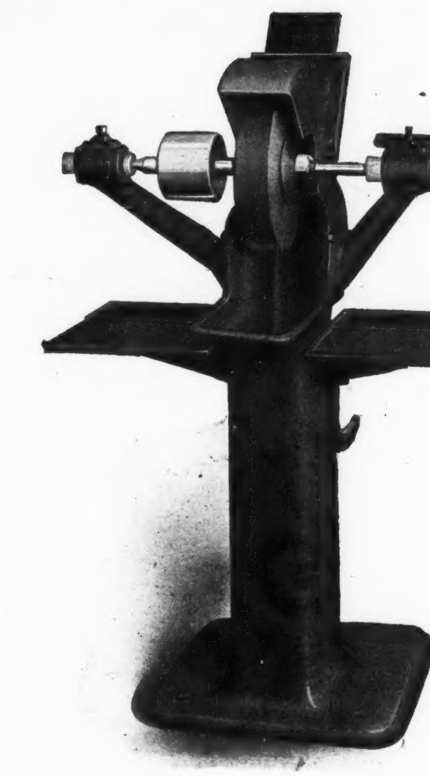

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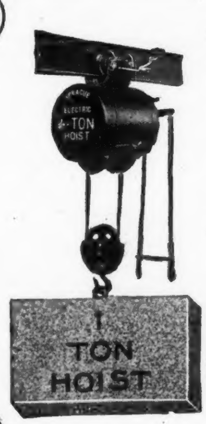

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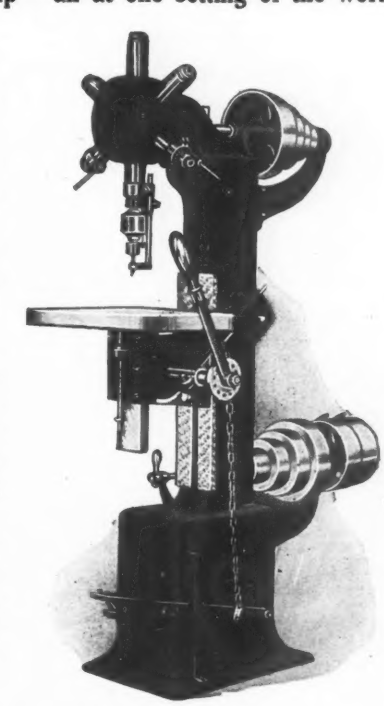

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Jones & Lamson Mch. Co., Springfield, Vt.
Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich.
Pierce Mch. Tool Co., 617 W. Jackson Blvd., Chicago, Ill.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Universal Mchy. Co., Milwaukee, Wis.
Warner & Swasey Co., Cleveland, O.
Wells & Son Co., F. E., Greenfield, Mass.
Wood Turret Mch. Co., Brazil, Ind.

Screw Machines, Multiple Spindle
Cincinnati Automatic Mch. Co., Oakley, Cincinnati, O.
Fitchburg Automatic Mch. Works, Fitchburg, Mass.
National Acme Co., Cleveland, O.
New Britain Mch. Co., New Britain, Conn.

Screw Machine Tools and Equipment
Bardons & Oliver, Cleveland, O.
Brown & Sharpe Mfg. Co., Providence, R. I.
Chicago Automatic Mch. Co., Chicago, Ill.
Cincinnati Automatic Mch. Co., Oakley, Cincinnati, O.
Cleveland Automatic Mch. Co., Cleveland, O.
Foster Mch. Co., Elkhart, Ind.
Garvin Mch. Co., Spring and Varick Sts., New York.
Harris Engineering Co., H. E., Bridgeport, Conn.
Himoff Mch. Co., 45 Mills St., Astoria, N. Y.
Jones & Lamson Mch. Co., Springfield, Vt.
Macnab Mchy. Co., John, 90 West St., New York.
National Acme Co., Cleveland, O.
New Britain Mch. Co., New Britain, Conn.
Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich.
Pierce Mch. Tool Co., 617 W. Jackson Blvd., Chicago, Ill.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Pratt & Whitney Co., Hartford, Conn.
Warner & Swasey Co., Cleveland, O.
Wells & Son Co., F. E., Greenfield, Mass.
Wood Turret Mch. Co., Brazil, Ind.

Screw Machine Work
Albaugh-Dover Co., 2100 Marshall Blvd., Chicago, Ill.
Blum & Co., Julius, 510 W. 24th St., New York.
Brown Engineering Co., 133 N. 3d St., Reading, Pa.
Cincinnati Screw Co., Cincinnati, O.
Interstate Mch. Products Co., Inc., Rochester, N. Y.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
National Acme Co., Cleveland, O.
Ohmer Fare Register Co., Dayton, O.
Toledo Screw Products Co., Toledo, O.

Screw Plates
Bay State Tap & Die Co., Mansfield, Mass.
Besly & Co., Chas. H., 120-B N. Clinton St., Chicago, Ill.
Brubaker & Bros., W. L., Millersburg, Pa.
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hart Mfg. Co., E. 20th St. and Marion Ave., Cleveland, O.
Morse Twist Drill & Mch. Co., New Bedford, Mass.
Hjorth Lathe & Tool Co., Boston, Mass.
Wells & Son Co., F. E., Greenfield, Mass.

Screws, Cap and Set
Allen Mfg. Co., Hartford, Conn.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
National Acme Co., Cleveland, O.
Toledo Screw Products Co., Toledo, O.

Screws, Machine
Allen Mfg. Co., Hartford, Conn.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
National Acme Co., Cleveland, O.
Toledo Screw Products Co., Toledo, O.

Screws, Special Lead, Feed, Etc.
Automatic Mch. Co., Bridgeport, Conn.

Second-hand Machinery, Etc.
Biggs-Watterson Co., Cleveland, O.
Brownell Machinery Co., Providence, R. I.
Cincinnati Planer Co., Cincinnati, O.
Davis Mch. Tool Co., Inc., Rochester, N. Y.
Davis Mch. Tool Co., W. F., 32 N. Clinton St., Chicago, Ill.
Easley Mchy. Co., E. L., Chicago, Ill.
Federal Mchy. Sales Co., 14 N. Jefferson St., Chicago, Ill.
Frasse & Co., Inc., Peter A., 417 Canal St., New York.
Gair Co., Robert, 50 Washington St., Brooklyn, N. Y.
Goodyear Tire & Rubber Co., Akron, O.
Gurney Elevator Co., 62 W. 45th St., New York.
Heppenstall Forge & Knife Co., Pittsburgh, Pa.
Hill, Clarke & Co., Inc., Boston, Mass.
Hill, Clarke & Co., of Chicago, 625 Washington Blvd., Chicago, Ill.
Hudson Motor Car Co., Detroit, Mich.
Marshall & Huschart Mchy. Co., 17 S. Jefferson St., Chicago, Ill.
McDonough Mfg. Co., Eau Claire, Wis.
McShane Bell Foundry Co., Baltimore, Md.
Motch & Merryweather Mchy. Co., Cleveland, O.
New Jersey Mchy. Exchange, Newark, N. J.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Patterson Tool & Supply Co., Dayton, O.
Prentiss & Co., Inc., Henry, 149 Broadway, New York.
Puffer Mfg. Co. Winchester, Mass.
Riverside Machinery Depot, Detroit, Mich.
Simmons Mch. Co., 1001 Singer Bldg., New York.
Standard Metal Mfg. Co., Newark, N. J.
Strong, Homer, Rochester, N. Y.
Union Switch & Signal Co., Swissvale, Pa.
Vandyck Churchill Co., 149 Broadway, New York.
Walsh Mchy. Co., M. J., Milwaukee, Wis.
Worthington Pump & Mchy. Corp., 115 Broadway, New York.
Young, Corley & Dolan, Inc., 115 Broadway, New York.

Separators, Oil and Steam
Nickolson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.

Set Screws, Safety
Allen Mfg. Co., Hartford, Conn.
Bristol Co., Waterbury, Conn.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
Standard Pressed Steel Co., Philadelphia, Pa.

Shafting, Steel
Blum & Co., Julius, 510 W. 24th St., New York.
Brown Co., A. & F., 79 Barclay St., New York.
Cresson-Morris Co., Philadelphia, Pa.
Standard Pressed Steel Co., Philadelphia, Pa.

Shapers
American Tool Works Co., Cincinnati, O.
Cincinnati Shaper Co., Cincinnati, O.
Cochrane-Bly Co., Rochester, N. Y.
Davis Mch. Tool Co., Inc., Rochester, N. Y.
Gould & Eberhardt, Newark, N. J.
Hendey Mch. Tool Co., Torrington, Conn.
Kelly Co., R. A., Xenia, O.
Morton Mfg. Co., Muskegon Heights, Mich.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Ohio Machine Tool Co., Kenton, O.
Potter & Johnston Mch. Co., Pawtucket, R. I.
Smith & Mills Co., Cincinnati, O.
Springfield Mch. Tool Co., 631 Southern Ave., Springfield, O.
Steptoe Co., John, Cincinnati, O.

Shapers, Vertical
Ingersoll-Rand Co., 11 Broadway, New York.
Pratt & Whitney Co., Hartford, Conn.

Shears, Rotary
Bliss Co., E. W., 5 Adams St., Brooklyn, N. Y.
Niagara Mch. & Tool Works, Buffalo, N. Y.
Toledo Mch. & Tool Co., Toledo, O.

Shears, Squaring
Erie Foundry Co., Erie, Pa.

Sheet Metal Work
Littleford Bros., Cincinnati, O.

Sheet Metal Working Machinery, (See Presses)
Savage Co., Inc., W. J., Knoxville, Tenn.

Shell Making Machinery
Thurlow-Steel Works, Inc., Philadelphia, Pa.

Slide Rests
National Acme Co., Cleveland, O.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.

Slotters, Machine
Baker Bros., Toledo, O.
Dill Mch. Co., T. C., Philadelphia, Pa.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
Niles-Bement-Pond Co., 111 Broadway, New York.
Sellers & Co., Inc., Wm., Philadelphia, Pa.

Slotters, Portable
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.

Sockets, Sleeves, Collets, Etc.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Frasse & Co., Peter A., 417 Canal St., New York.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
Montgomery & Co., Inc., 104 Fulton St., New York.
Morse Twist Drill & Machine Co., New Bedford, Mass.
National Twist Drill & Tool Co., Detroit, Mich.
Pratt & Whitney Co., Hartford, Conn.
Standard Tool Co., Cleveland, O.
Union Twist Drill Co., Athol, Mass.
Whitman & Barnes Mfg. Co., 1000 W. 120th St., Chicago, Ill.

Special Machinery and Tools
American Mch. & Foundry Co., 5520 2nd Ave., Brooklyn, N. Y.
Automatic Mch. Co., Bridgeport, Conn.
Automat Tool Works, 252 Greenwich St., New York.
Baird Mch. Co., Bridgeport, Conn.
Beaman & Smith Co., Providence, R. I.
Bilgram Mch. Works, 1231 Spring Garden St., Philadelphia, Pa.
Blake & Johnson Co., Waterbury, Conn.
Blanchard Machine Co., 64 State St., Cambridge, Mass.
Bliss Co., E. W., 5 Adams St., Brooklyn, N. Y.
Brown Co., A. & F., 79 Barclay St., New York.
Buffalo Foundry & Mch. Co. 10 Winchester Ave., Buffalo, N. Y.
Carroll Engineering Co., Dayton, O.
Columbus Die, Tool & Machine Co., Columbus, O.
Earle Gear & Mch. Co., 4705 Stenton Ave., Philadelphia, Pa.
Fawcus Machine Co., Pittsburgh, Pa.
Gardam & Sons, Inc., Wm., 108 Park Place, New York.
Garvin Mch. Co., Spring and Varick Sts., New York.
Gisholt Mch. Co., Madison, Wis.
Grant Mfg. & Mch. Co., N. W. Station, Bridgeport, Conn.
Hanna Engineering Works, 1763 Elston Ave., Chicago, Ill.
Hannifin Mfg. Co., Chicago, Ill.
Harris Engineering Co., H. E., Bridgeport, Conn.
Hetherington-McCabe Co., Piqua, O.
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Horton & Sons Co., E., Windsor Locks, Conn.
Ingle Machine Co., Rochester, N. Y.
Krasberg Mfg. Co., 412 Orleans St., Chicago, Ill.
Langelier Mfg. Co., Providence, R. I.
Lucas Machine Tool Co., Cleveland, O.
Mehl Mch. Tool & Die Co., Roselle, N. J.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Meisselbach-Catucci Mfg. Co., 27 Congress St., Newark, N. J.
Middlesex Mch. Works, Middletown, Conn.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Mueller Mch. Tool Co., Cincinnati, O.
National Automatic Tool Co., Richmond, Ind.
National Machinery Co., Tiffin, O.
National Tool Co., Cleveland, O.
National Twist Drill & Tool Co., Detroit, Mich.
Nelson Tool Co., Inc., 781-783 E. 142nd St., New York.
New Britain Mch. Co., New Britain, Conn.
Newman Mfg. Co., Cincinnati, O.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia, Pa.
North Side Tool Works, Dayton, O.
Ohmer Fare Register Co., Dayton, O.
Pratt & Whitney Co., Hartford, Conn.
Reed-Prentice Co., F. E. Reed Dept. and Prentice Bros. Dept., Worcester, Mass.
Reliance Steel & Tool Co., Inc., 30 Church St., New York.
Shuster Co., F. B., New Haven, Conn.
Simonds Mfg. Co., Pittsburgh, Pa.
Slocum, Avram & Slocum Laboratories, Inc., 531 W. 21st St., New York.
S-P Mfg. Co., Cleveland, O.
Standard Engineering Co., Ellwood City, Pa.
Steel Products Engineering Co., Springfield, O.
Steiner Bros., Lima, O.
Swedish Gage Co., Inc., 16 W. 61st St., New York.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
Taylor & Fenn Co., Hartford, Conn.
Taylor-Shantz Co., Rochester, N. Y.
T. C. M. Mfg. Co., Harrison, N. J.
Toledo Mch. & Tool Co., Toledo, O.
Treadwell Engineering Co., Easton, Pa.
Ulmer Co., J. C., Cleveland, O.
Windau Tool Co., Cleveland, O.

Speed Changing Devices
Moore & White Co., 2707-2737 N. 15th St., Philadelphia, Pa.

Spring Coiling and Forming Machinery
Baird Machine Co., Bridgeport, Conn.

Springs
Barnes Co., Wallace, South and Parallel Sts., Bristol, Conn.
Blum & Co., Julius, 510 W. 24th St., New York.
Kokomo Spring Co., Kokomo, Ind.

Sprocket Chains
Baldwin Chain & Mfg. Co., Worcester, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Caldwell & Son Co., H. W., 17th St. and Western Ave., Chicago, Ill.
Cullman Wheel Co., 1339 Altgeld St., Chicago, Ill.
Diamond Chain & Mfg. Co., 240 W. Georgia St., Indianapolis, Ind.
Link-Belt Company, Chicago, Ill.
Morse Chain Co., Ithaca, N. Y.
Philadelphia Gear Works, Vine and 11th Sts., Philadelphia, Pa.
Union Chain & Mfg. Co., Seville, O.
Whitney Mfg. Co., Hartford, Conn.
Woburn Gear Works, Woburn, Mass.

Sprockets
Boston Gear Works, Norfolk Downs, Mass.
Cullman Wheel Co., 1339 Altgeld St., Chicago, Ill.
Link-Belt Co., Chicago, Ill.
Meisel Press Mfg. Co., 948 Dorchester Ave., Boston, Mass.
Philadelphia Gear Works, Vine and 11th Sts., Philadelphia, Pa.
Woburn Gear Works, Woburn, Mass.

Squaring Machines
Bickford Machine Co., Greenfield, Mass.
Erie Foundry Co., Erie, Pa.

Stampings, Sheet Metal
Acklin Stamping Co., 1657 Dorr St., Toledo, O.
American Tool & Mfg. Co., Urbana, O.
Blum & Co., Julius, 510 W. 24th St., New York.
Fox Gun Co., A. H., Philadelphia, Pa.
Globe Mch. & Stamping Co., Cleveland, O.
Lansing Stamping & Tool Co., Lansing, Mich.
Rockford Metal Specialty Co., Rockford, Ill.
Solar Metal Products Co., Inc., Columbus, O.

Stamps, Letters and Figures, Steel
Hoggson & Pettis Mfg. Co., New Haven, Conn.
Matthews & Co., Jas. H., 3946 Forbes Field, Pittsburgh, Pa.
Newman Mfg. Co., Cincinnati, O.
Noble & Westbrook Mfg. Co., Hartford, Conn.
Pannier Bros. Stamp Co., Inc., Pittsburgh, Pa.
Schwerdtle Stamp Co., Bridgeport, Conn.

Steam Specialties
National Tube Co., Pittsburgh, Pa.
Reliance Gauge Column Co., 6008 Carnegie Ave., Cleveland, O.

Steel
Apex Steel Corporation, 50 Church St., New York.
Bethlehem Steel Co., South Bethlehem, Pa.
Blum & Co., Julius, 510 W. 24th St., New York.
Boker & Co., Inc., H., 101 Duane St., New York.
Camden Forge Co., Camden, N. J.
Colonial Steel Co., Pittsburgh, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Frasse & Co., Inc., Peter A., 417 Canal St., New York.
Halcomb Steel Co., Syracuse, N. Y.
Hawkridge Bros. Co., Boston, Mass.
Heller Bros. Co., Newark, N. J.
Jessop & Sons, Inc., Wm., 91 John St., New York.
Johnston & Jennings Co., Addison Road and Lake Shore R. R. Tracks, Cleveland, O.
Latrobe Electric Steel Co., Latrobe, Pa.
Standard Alloys Co., Pittsburgh, Pa.
Vanadium-Alloys Steel Co., Pittsburgh, Pa.
Vulcan Crucible Steel Co., Aliquippa, Pa.

Steel, Cold Rolled Strip, Sheet and Wire
Driver-Harris Co., Harrison, N. J.

Steel, High Speed, Tool
Apex Steel Corporation, 50 Church St., New York.
Bethlehem Steel Co., South Bethlehem, Pa.
Blum & Co., Julius, 510 W. 24th St., New York.
Boker & Co., Inc., H., 101 Duane St., New York.
Colonial Steel Co., Pittsburgh, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Frasse & Co., Inc., Peter A., 417 Canal St., New York.
Halcomb Steel Co., Syracuse, N. Y.
Hawkridge Bros. Co., Boston, Mass.
Haynes Stellite Co., Kokomo, Ind.
Heller Bros. Co., Newark, N. J.
Jessop & Sons, Inc., Wm., 91 John St., New York.
Latrobe Electric Steel Co., Latrobe, Pa.
Onondaga Steel Co., Inc., Syracuse, N. Y.
Reliance Steel & Tool Co., Inc., 30 Church St., New York.
Standard Alloys Co., Pittsburgh, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Vanadium-Alloys Steel Co., Pittsburgh, Pa.
Vulcan Crucible Steel Co., Aliquippa, Pa.

Steel, Machine
Apex Steel Corporation, 50 Church St., New York.
Bethlehm Steel Co., South Bethlehem, Pa.
Blum & Co., Julius, 510 W. 24th St., New York.
Boker & Co., Inc., H., 101 Duane St., New York.
Camden Forge Co., Camden, N. Y.
Colonial Steel Co., Pittsburgh, Pa.
Firth-Sterling Steel Co., McKeesport, Pa.
Halcomb Steel Co., Syracuse, N. Y.
Hawkridge Bros. Co., Boston, Mass.
Jessop & Sons, Inc., Wm., 91 John St., New York.
Latrobe Electric Steel Co., Latrobe, Pa.
Standard Alloys Co., Pittsburgh, Pa.
Standard Gauge Steel Co., Beaver Falls, Pa.
Standard Alloys Co., Pittsburgh, Pa.
Vanadium-Alloys Steel Co., Pittsburgh, Pa.
Vulcan Crucible Steel Co., Aliquippa, Pa.

Steel Shelving, Racks, Barrels, Tables, Etc.
Manufacturing Equipment & Eng. Co., Framingham, Mass.
National Scale Co., Chicopee Falls, Mass.
New Britain Mch. Co., New Britain, Conn.

Stellite
Haynes Stellite Co., Kokomo, Ind.

Stocks, Die
See Taps and Dies.

Stones, Oil
American Emery Wheel Works, Providence, R. I.
Caborundum Co., Niagara Falls, N. Y.
Norton Co., Worcester, Mass.
Vitrified Wheel Co., Westfield, Mass.

Stools, Steel
See Furniture, Shop and Drafting-room.

Straightening Machinery
Morse Twist Drill & Machine Co., New Bedford, Mass.
Niles-Bement-Pond Co., 111 Broadway, New York.
Shuster Co., F. B., New Haven, Conn.

Stud Setters, Opening
Errington Mechanical Laboratory, 39 Cortlandt St., New York.

Swaging Machines
Etna Machine Co., Toledo, O.
Excelsior Needle Co., Torrington, Conn.
Langelier Mfg. Co., Providence, R. I.

Switchboards
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Switches
General Electric Co., Schenectady, N. Y.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Tachometers and Thermometers
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
Veeder Mfg. Co., 39 Sargeant St., Hartford, Conn.

Tapes, Measuring
Keuffel & Esser Co., Hoboken, N. J.
Starrett Co., L. S., Athol, Mass.
Ulmer Co., J. C., Cleveland, O.

Tapping Attachments and Devices
American Tool Works Co., Cincinnati, O.
Baker Bros., Toledo, O.
Barnes Co., W. F. & John, 231 Ruby St., Rockford, Ill.
Beaman & Smith Co., Providence, R. I.
Bicknell-Thomas Co., Greenfield, Mass.
Cincinnati Bickford Tool Co., Oakley, Cincinnati, O.
Errington Mechanical Laboratory, 39 Cortlandt St., New York.
Geometric Tool Co., New Haven, Conn.
Hammond Mfg. Co., Cleveland, O.
Leland-Gifford Co., Worcester, Mass.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Newman Mfg. Co., Cincinnati, O.
Peter Bros. Mfg. Co., 135 Railroad Ave., Algonquin, Ill.
Procunier, Wm. L., 549 Washington Blvd., Chicago, Ill.
Quint, A. E., Hartford, Conn.
Wells & Son Co., F. E., Greenfield, Mass.
Whitney Mfg. Co., Hartford, Conn.

Tapping Machines
Acme Mchy. Co., Cleveland, O.
Baker Bros., Toledo, O.
Fulton Foundry & Mch. Co., Brooklyn, N. Y.
Garvin Mch. Co., Spring and Varick Sts., New York.
Geometric Tool Co., New Haven, Conn.
Hammond Mfg. Co., Cleveland, O.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Harris Engineering Co. H. E., Bridgeport, Conn.
Langelier Mfg. Co., Providence, R. I.
Moline Tool Co., Moline, Ill.
National Mchy. Co., Tiffin, O.
Peter Bros. Mfg. Co., 135 Railroad Ave., Algonquin, Ill.
Procunier, Wm. L., 549 Washington Blvd., Chicago, Ill.
Rockford Drilling Mch. Co., Rockford, Ill.
Saunders' Sons, D., Yonkers, N. Y.

Taps and Dies
Bay State Tap & Die Co., Mansfield, Mass.
Besly & Co., Chas. H., 120-B N. Clinton St., Chicago, Ill.
Brubaker & Bros., W. L., Millersburg, Pa.
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket, R. I.
Errington Mechanical Laboratory, 39 Cortlandt St., New York.
Geometric Tool Co., New Haven, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
Hardinge Bros., Inc., Berteau and Ravenswood Aves., Chicago, Ill.
Harris Engineering Co., H. E., Bridgeport, Conn.
Hart Mfg. Co., E. 20th St. and Marion Ave., Cleveland, O.
Hjorth Lathe & Tool Co., Boston, Mass.
Morse Twist Drill & Machine Co., New Bedford, Mass.
National Acme Co., Cleveland, O.
Nicholson & Co., W. H., 112 Oregon St., Wilkes-Barre, Pa.
Pratt & Whitney Co., Hartford, Conn.
Reed Mfg. Co., Erie, Pa.
Reiff & Nestor, Lykens, Pa.
Reliance Steel & Tool Co., Inc., 30 Church St., New York.
Rogers Works, Inc., J. M., Gloucester City, N. J.
Saunders' Sons, D., Yonkers, N. Y.
Stnadard Tool Co. Cleveland, O.
Walworth Mfg. Co., Boston, Mass.
Wells & Son Co., F. E., Greenfield, Mass.

Taps, Collapsing
Errington Mechanical Laboratory, 39 Cortlandt St., New York.
Geometric Tool Co., New Haven, Conn.
Manufacturers' Equipment Co., 175 N. Jefferson St., Chicago, Ill.
Modern Tool Co., 2nd and State Sts., Erie, Pa.
Murchey Mch. & Tool Co., 34 Porter St., Detroit, Mich.
Victor Tool Co., Waynesboro, Pa.

Testing Outfits, Hydraulic
Metalwood Mfg. Co., Detroit, Mich.

Thread Cutting Machinery
Automatic Machine Co., Bridgeport, Conn.
Bickford Machine Co., Greenfield, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Geometric Tool Co., New Haven, Conn.
Greenfield Tap & Die Corp., Greenfield, Mass.
Lees-Bradner Co., Cleveland, O.
National Mchy. Co., Tiffin, O.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts., Philadelphia. Pa.
Pratt & Whitney Co., Hartford, Conn.
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.
Wells & Son Co., F. E., Greenfield, Mass.

Thread Cutting Machines, Semi-automatic
Chicago Automatic Mch. Co., Chicago, Ill.
Macnab Mchy. Co., John, 90 West St., New York.
Newton Mch. Tool Works, Inc., 23rd and Vine Sts. Philadelphia, Pa.

Thread Cutting Tools
Rivett Lathe & Grinder Co., Brighton, Boston, Mass.

Thread Milling Machines
Bickford Mch. Co., Greenfield, Mass.
Biggs-Watterson Co., Cleveland, O.
Gisholt Mch. Co., Madison, Wis.
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Lees-Bradner Co., Cleveland, O.
Newton Mch. Tool Works, Inc., 23d and Vine Sts., Philadelphia, Pa.
Pratt & Whitney Co., Hartford, Conn.
Smalley-General Co., Bay City, Mich.
Taft-Peirce Mfg. Co., Woonsocket, R. I.
T. C. M. Mfg. Co., Harrison, N. J.
Waltham Mch. Works, Waltham, Mass.

Thread Rolling Machines
Acme Mchy. Co., Cleveland, O.
Blake & Johnson Co., Waterbury, Conn.
National Mchy. Co., Tiffin, O.

Time Recorders, Workmen's Time on the Job
Gisholt Mch. Co., Madison, Wis.

Tire Welders and Benders
Williams, White & Co., Moline, Ill.

Tool Cases
Gerstner & Sons, H., Dayton, O.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
Starrett Co., L. S., Athol, Mass.
Union Tool Chest Works, 10 Railroad St., Rochester, N. Y.
Wedell & Boers, Detroit, Mich.

Tool Holders
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Billings & Spencer Co., Hartford, Conn.
Cleveland Twist Drill Co., Cleveland, O.
Gisholt Mch. Co., Madison, Wis.
Hammacher, Schlemmer & Co., 4th Ave. and 13th St., New York.
O. K. Tool Holder Co., Shelton, Conn.
Osgood Tool Co., J. L., Buffalo, N. Y.
Ready Tool Co., Bridgeport, Conn.
Western Tool & Mfg. Co., Springfield, O.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.
Windau Tool Co., Cleveland, O.

Tool Salvage
Detroit Reamer Salvage Co., Detroit, Mich.

Tracing Cloth and Paper
Keuffel & Esser Co., Hoboken, N. J.

Tracing Filing Cabinets
See Cabinets, Filing.

Tracks, Trolley and Overhead
Harrington, Son & Co., Inc., Edwin, Philadelphia, Pa.
Northern Engineering Works, Detroit, Mich.
Yale & Towne Mfg. Co., 9 E. 40th St., New York.

Transformers
Eck Dynamo & Motor Co., Belleville, N. J.
General Electric Co., Schenectady, N. Y.
Reliance Elec. & Eng. Co., 1056 Ivanhoe Road, Cleveland, O.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Transmission Machinery
See Hangers, Shafting, Pulleys, Clutches, Couplings, Belting, Chain, etc.

Trolleys and Tramways
Box & Co., Alfred, Philadelphia, Pa.
Curtis Pneumatic Mchy. Co., 1568 Kienlen Ave., St. Louis, Mo.
Wright Mfg. Co., Lisbon, O.
Yale & Towne Mfg. Co., 9 E. 40th St., New York

Trucks
Barrett-Cravens Co., 750 Transportation Bldg., Chicago, Ill.
Chase Foundry & Mfg. Co., Columbus, O.
Greenfield Tap & Die Corp., Greenfield, Mass.
National Scale Co., Chicopee Falls, Mass.
Transmission Ball Bearing Co., Inc., Buffalo, N. Y.

Trucks, Elevating
Barrett-Cravens Co., 750 Transportation Bldg., Chicago, Ill.
Chase Foundry & Mfg. Co., Columbus, O.
National Scale Co., Chicopee Falls, Mass.
Stuebing Truck Co., Cincinnati, O.
Transmission Ball Bearing Co., Inc., Buffalo, N. Y.

Tube Expanders
Watson-Stillman Co., 192 Fulton St., New York.

Tubing, Flexible
Almond Mfg. Co., T. R., 2 Maple Ave., Ashburnham, Mass.
Wheelock Mfg. Co., Wheelock, Vermont.

Tubing, Seamless Steel
Blum & Co., Julius, 510 W. 24th St., New York.
Frasse & Co., Inc., Peter A., 417 Canal St., New York.
National Tube Co., Pittsburgh, Pa.
Roux & Heyberger, 108 Rue Lafayette, Paris, France.
Standard Parts Co., Cleveland O.

Tubing, Steel
Blum & Co., Julius, 510 W. 24th St., New York.
Frasse & Co., Inc., Peter A., 417 Canal St., New York.
National Tube Co. Pittsburgh, Pa.
Standard Parts Co., Cleveland, O.

Tubing, Welded Steel
Empire Art Metal Co., Inc., College Point, N. Y.
Roux & Heyberger, 108 Rue Lafayette, Paris, France.

Tumbling Barrels
Abbott Ball Co., Elmwood, Hartford, Conn.
Baird Mch. Co., Bridgeport, Conn.
Globe Mch. & Stamping Co., Cleveland, O.
Royersford Fdry. & Mch. Co., 54 N. 5th St., Philadelphia, Pa.

Turntables
Canton Foundry & Mch. Co., Canton, O.
Chase Fdry. & Mfg. Co., Columbus, O.
Link-Belt Company, Chicago, Ill.

Turret Attachments
Almond Mfg. Co., T. R., 2 Maple Ave., Ashburnham, Mass.
Meisselbach-Catucci Mfg. Co., 27 Congress St., Newark, N. J.
Newman Mfg. Co., Cincinnati, O.
Phoenix Mfg. Co., Eau Claire, Wis.
Pierce Mch. Tool Co., 617 W. Jackson Blvd., Chicago, Ill.
Seneca Falls Mfg. Co., 330 Fall St., Seneca Falls, N. Y.

Turret Lathes, Vertical
Bullard Mch. Tool Co., Bridgeport, Conn.
Pratt & Whitney Co., Hartford, Conn.

Twist Drills
See Drills, Twist.

Unions
Dart Mfg. Co., E. M., Providence, R. I.
National Tube Co., Pittsburgh, Pa.

Universal Joints
Baush Mch. Tool Co., 200 Wason Ave., Springfield, Mass.
Boston Gear Works, Norfolk Downs, Mass.
Gray & Prior Mch. Co., 38 Suffield St., Hartford, Conn.

Valve Leathers
Graton & Knight Mfg. Co., Worcester, Mass.

Valves
Elmes Eng. Works, Chas. F., 222 N. Morgan St., Chicago, Ill.
Hydraulic Press Mfg. Co., 84 Lincoln Ave., Mt. Gilead, O.
Metalwood Mfg. Co., Detroit, Mich.
National Tube Co., Pittsburgh, Pa.
Watson-Stillman Co., 192 Fulton St., New York.

Varnish
Glidden Varnish Co., Cleveland, O.

Ventilating Apparatus
Buffalo Forge Co., Buffalo, N. Y.

Vise Stands
New Britain Mch. Co., New Britain, Conn.
Western Tool & Mfg. Co., Springfield, O.

Vises, Bench
Athol Mch. Co., Athol, Mass.
Billings & Spencer Co., Hartford, Conn.
Goodell-Pratt Co., Greenfield, Mass.
New Britain Mch. Co., New Britain, Conn.
Prentiss Vise Co., 106 Lafayette St., New York.
Reed Mfg. Co., Erie, Pa.
Western Tool & Mfg. Co., Springfield, O.

Vises, Drill
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Brown Engineering Co., 133 No. 3d St., Reading, Pa.
Carter & Hakes Co., Sterling Place, Winsted, Conn.
Graham Mfg. Co., Providence, R I.
Skinner Chuck Co., New Britain, Conn.

Vises, Milling
New Jersey Mchy. Exchange, Newark, N. J.

Vises, Pipe
Bignall & Keeler Mch. Works, Edwardsville, Ill.
Butterfield & Co., Derby Line, Vt.
Curtis & Curtis Co., 8 Garden St., Bridgeport, Conn.
Reed Mfg. Co., Erie, Pa.
Saunders' Sons, D., Yonkers, N. Y.
Walworth Mfg. Co., Boston, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Vises, Planer and Shaper
American Tool Works Co., Cincinnati, O.
Cincinnati Planer Co., Cincinnati, O.
Hendey Machine Co., Torrington, Conn.
Sellew Mch. Tool Co., Pawtucket, R. I.
Skinner Chuck Co., New Britain, Conn.

Vises, Universal Machine
Boston Scale & Mch. Co., Boston, Mass.
Brown & Sharpe Mfg. Co., Providence, R. I.
Brown Engineering Co., 133 No. 3d St., Reading, Pa.
Graham Mfg. Co., Providence, R. I.
New Jersey Mchy. Exchange, Newark, N. J.
Skinner Chuck Co., New Britain, Conn.

Voltmeters
Bristol Co., Waterbury, Conn.
Brown Instrument Co., Philadelphia, Pa.
General Electric Co., Schenectady, N. Y.

Washers, Leather
Graton & Knight Mfg. Co., Worcester, Mass.
Schieren Co., Chas. A., 73 Ferry St., New York.

Washers, Spacing
See Collars, Spacing, etc.
Maxwell-Hutchcroft Co., Cleveland, O.

Washstands and Bowls
Manufacturing Equipment & Eng. Co., Framingham, Mass.

Water Coolers
Allen Filter Co., Toledo, O.
Manufacturing Equipment & Eng. Co., Framingham, Mass.

Welding and Cutting, Job
Davis-Bournonville Co., Jersey City, N. J.
Electric Welding Co., Cleveland, O.
General Electric Co., Schenectady, N. Y.
National Electric Welder Co., Warren, O.
Prest-O-Lite Co., Inc., 837 Speedway, Indianapolis, Ind.
Standard Parts Co., Cleveland, O.
Thomson Elec. Welding Co., Lynn, Mass.
Thomson Spot Welder Co., Lynn, Mass.
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Welding and Cutting, Oxy-Acetylene Equipment
Davis-Bournonville Co., Jersey City, N. J.
Prest-O-Lite Co., Inc., 837 Speedway, Indianapolis, Ind.

Welding Equipment, Electric Arc
Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

Welding Machines, Electric
Electric Welding Co., Cleveland, O.
General Electric Co., Schenectady, N. Y.
National Electric Welder Co., Warren, O.
Thomson Electric Welding Co., Lynn, Mass.
Thomson Spot Welder Co., Lynn, Mass.

Welding Rods and Wire
Apex Steel Corporation, 50 Church St., New York.
Davis-Bournonville Co., Jersey City, N. J.

Wire-Nail and Washer Machinery
National Mchy. Co., Tiffin, O.

Wire Straighteners and Cutters, Automatic
Shuster Co., F. B., New Haven, Conn.

Wire Working Machinery
Baird Machine Co., Bridgeport, Conn.
Cleveland Mch. & Mfg. Co., 4944 Hamilton Ave., Cleveland, O.
Shuster Co., F. B., New Haven, Conn.

Wood Working Machinery
Crescent Mch. Co., 56 Main St., Leetonia, O.
New Britain Mch. Co., New Britain, Conn.
Oliver Machinery Co., 7 Coldbrook St., Grand Rapids, Mich.
Seneca Falls Mfg. Co., 330 Fall St., Seneca Falls, N. Y.
Sidney Tool Co., Sidney, O.

Wrenches
Armstrong Bros. Tool Co., 313 N. Francisco Ave., Chicago, Ill.
Armstrong Mfg. Co., 297 Knowlton St., Bridgeport, Conn.
Athol Mch. Co., Athol, Mass.
Billings & Spencer Co., Hartford, Conn.
Coes Wrench Co., Worcester, Mass.
Goodell-Pratt Co., Greenfield, Mass.
Greene, Tweed & Co., 109 Duane St., New York.
Trimont Mfg. Co., Roxbury, Mass.
Walworth Mfg. Co., Boston, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Whitman & Barnes Mfg. Co., 1000 West 120th St., Chicago, Ill.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Wrenches, Pipe
Greene, Tweed & Co., 109 Duane St., New York.
Reed Mfg. Co., Erie, Pa.
Trimont Mfg. Co., Roxbury, Mass.
Walworth Mfg. Co., Boston, Mass.
Wells & Son Co., F. E., Greenfield, Mass.
Whitman & Barnes Mfg. Co., 1000 West 120th St., Chicago, Ill.
Williams & Co., J. H., 61 Richards St., Brooklyn, N. Y.

Wrenches, Ratchet
Goodell-Pratt Co., Greenfield, Mass.
Greene, Tweed & Co., 109 Duane St., New York.
Trimont Mfg. Co., Roxbury, Mass.

Wrenches, Tap
Besly & Co., Chas. H., 120-B N. Clinton St., Chicago, Ill.
Brubaker & Bros., W. L., Millersburg, Pa.
Butterfield & Co., Derby Line, Vt.
Card Mfg. Co., S. W., Mansfield, Mass.
Carpenter Tap & Die Co., J. M., Pawtucket R. I.
Greenfield Tap & Die Corp., Greenfield, Mass.
Morse Twist Drill & Machine Co., New Bedford, Mass.
Pratt & Whitney Co., Hartford, Conn.
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